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ABSTRACT

This document contains teacher's materials for a course on becoming an automotive brakes specialist, based on the National Institute of Automotive Service Excellence task lists. The course consists of three instructional units: service brake hydraulic system and wheel bearings, service drum brakes, and service disc brakes. Depending on the specific instructional objectives of a unit, a combination of the following materials is included for each instructional unit: (1) performance objectives; (2) suggested activities for the teacher; (3) information sheets; (3) job sheets; (4) transparency masters; (5) assignment sheets; (5) written tests; and (6) the answers to written tests and assignment pages. (CML)

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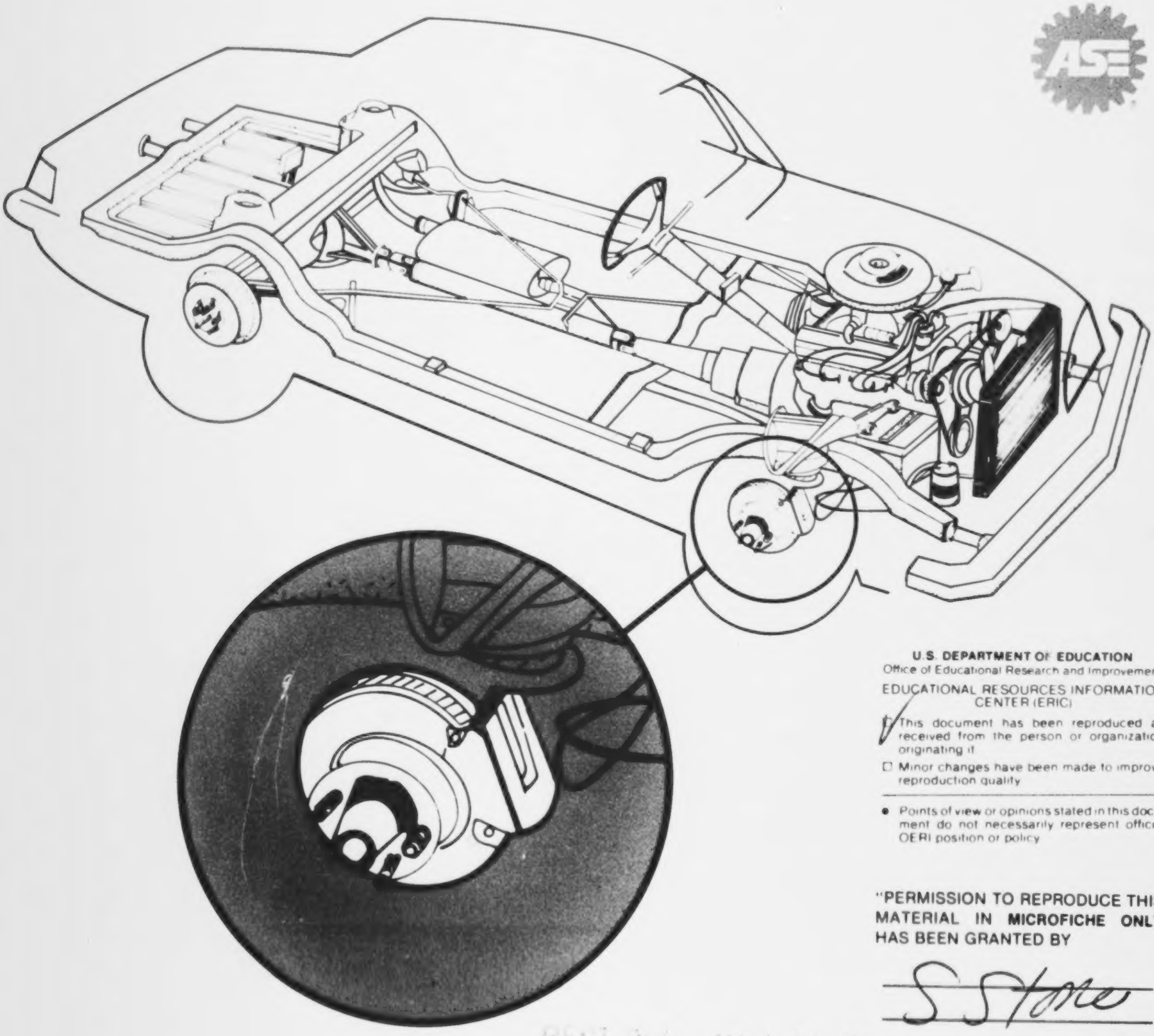
AUTOMOTIVE SERVICE SERIES

TEACHER
EDITION

BRAKES SPECIALIST



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Oklahoma State Department of
Vocational and Technical Education
Stillwater, Oklahoma

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Brakes Specialist

Developed by
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for
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FOREWORD

This is one in a series of eight automotive service specialty publications that are based on the National Institute of Automotive Service Excellence (ASE) task lists. This series provides instruction for all high-priority competencies established by ASE and will contribute greatly to an auto service technology program's ability to meet the requirements of a nationally certified training school.

The ASE competencies are developed by industry to meet the industry's need for quality technicians; therefore, this curriculum addresses this need. The industry and education committee that has validated the technical accuracy of this material must be commended for outstanding service and commitment to the quality of these instructional units. The instructors and students who use this material should be challenged to have the same commitment to excellence.

We trust that this instructional material will meet students' needs as they prepare for careers in automotive brakes service.

Roy Peters, Jr., State Director
Oklahoma State Department of
Vocational and Technical Education

Ivan Armstrong, State Supervisor
Trade and Industrial Education
Oklahoma State Department of
Vocational and Technical Education

PREFACE

The purpose of *Brakes Specialist* is to continue the student's training in the automotive service trade by providing instruction in this specialty area. This publication is one in a series of eight publications for automotive specialty areas. Other areas included in this series are steering and suspension, engine performance, electrical, heating and air conditioning, automatic transmission/transaxle, manual drivetrain and axles, and engine repair.

Instructors are faced with the challenge of teaching the skills and related information necessary for their students to become the highly qualified automotive service specialists that are in demand today. This curriculum guide is designed to help instructors meet this challenge. The objectives in this curriculum are based on those National Institute of Automotive Service Excellence (ASE) tasks that are required of an automotive brakes specialist.

ACKNOWLEDGEMENTS

Any project as comprehensive and involved as *Brakes Specialist* requires the contributions of many people. We are thankful for the support we have received in the development of this book.

Appreciation is given to the instructors and industry representatives who served on the technical review committee for their guidance during this project. These committee members assisted in reviewing the ASE task listings and reviewing the completed materials. The review committee included

Dewayne Arndt

Robert Betche

Dan Buckner

Charlie Brackett

C. C. Anderson

John W. Edsall

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Jon Priebe

Thank-you goes to the members of the Oklahoma State Department of Vocational and Technical Education staff who made the project possible: Roy Peters, Jr., State Director; Ivan Armstrong, Trade and Industrial State Supervisor; and Greg Pierce, CIMC Coordinator.

Appreciation is also extended to the members of the CIMC project development team, under the direction of Curriculum Development Coordinator Sheila Stone, assigned to this project. This team consisted of Sue Buck, Alan Barker, Susan Walker, and me. A very special thanks is extended to Chuck Pendergast for the advice and technical expertise shared with the development team members during the production of this curriculum guide. Special appreciation goes to Anita Kroth, secretary for Curriculum Development, for her assistance throughout the development process.

Others involved in the development process also deserve special thanks. Thank-you goes to the Communications Center staff, especially Rose Primeaux and Stephanie Smola, who were responsible for typesetting all the units of instruction. Thank-you also goes to the many artists in the Art Department, under the direction of Bob Davis, who contributed their talents to this project. Recognition also is due to Tom Fields of the CIMC Media Unit who did the photographic work for this volume.

It is sincerely hoped that these materials will be of value to automotive service instructors and that they benefit those students who pursue careers as automotive brakes specialists in the automotive industry.

Marsha Sneed
CIMC Editor

BRAKES SPECIALIST

INSTRUCTIONAL UNITS

Brakes Specialist includes three instructional units written in a standard format established in 1970 for the development of instructional materials for all Oklahoma vocational teachers and adapted in 1986 in response to user requests. The standard format included eight basic components that formed a unit of instruction: objective sheet, suggested activities for the teacher, information sheet, assignment sheets, job sheets, transparency masters, written test, and answers to written test and assignment sheets. Depending on the specific objectives, transparency masters, assignment sheets, or job sheets may or may not have been included in a unit of instruction. In the adapted format, seven additional components have been developed to better define knowledge and skill competencies of the occupation studied. These new components are instructor supplements, pretest and answers, student supplements, activity sheets and answers, and practical tests.

All of the unit components "zero in" on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

- Amount of material that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media, that must be ordered.
- Resource people who must be contacted.

OBJECTIVE SHEET
(White pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the performance necessary to reach the unit objective.

The unit objective states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to see whether the student can do it. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective can best be taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

SUGGESTED ACTIVITIES (Pink pages)

This component is included only in the instructor material. The suggested activities pages assist instructors during the preparation stage of the teaching/learning process by providing suggestions for delivery, application, and evaluation during the instructional process. Teaching suggestions are included for each objective. The instructor should read the suggested activities before teaching the units to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the "Suggested Resources" section, along with print and nonprint media that may be used to teach the unit. These materials can be used by the instructor to supplement her or his knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

INSTRUCTOR'S SUPPLEMENTS (Pink pages)

Instructor's supplements are optional materials for the instructor to use. They have three purposes: to provide the instructor with higher-level materials to stretch the advanced student, with remedial information or practice to assist the less advanced student, and with state-of-the-art information in which the instructor may not have a background or with information that is not readily available in other textbooks or service manuals.

TRANSPARENCY MASTERS (Pink pages)

Transparencies are graphic materials used to direct the students' attention to the topic of discussion. They may present new information, or they may reinforce information presented in the information sheet or in the assignment sheets.

PRETEST ANSWERS (Pink pages)

The answers to the pretest are given in this component along with a table that correlates the pretest items and the specific objectives.

PRETEST (White pages)

The pretests consist of multiple-choice questions designed to give students exposure to ASE-certification-style test questions. The questions duplicate the learning level of the specific objectives and include questions covering information-sheet and assignment-sheet competencies and job-sheet skills.

INFORMATION SHEET
(Green pages)

The information sheet provides "must know" content essential for meeting the cognitive objectives on the knowledge and comprehension level of Bloom's taxonomy of educational objectives. The information is presented in outline form and is keyed to the specific objectives.

Instructors will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and instructors to add notes that supplement, localize, personalize, or provide motivation for each unit.

STUDENT SUPPLEMENTS
(Green pages)

Student supplements are included in the student material. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information in the completion of assignment-sheet or job-sheet objectives will be evaluated when completing those particular assignments.

ASSIGNMENT SHEETS
(Brown pages)

Assignment sheets provide students with information and exercises or problems that address learning levels at or above the application level of Bloom's taxonomy. The assignment sheets give students an opportunity to apply information they have learned or to apply nontested information presented in a student supplement. Answer sheets are provided.

ACTIVITY SHEETS
(White pages)

Activity sheets provide students with nontested activities designed to expand the students' appreciation of the subject area studied or to provide additional practice exercises over tested objectives. These activities often address the affective domain and may include such things as written or oral reports, personal inventory exercises, or additional problem-solving exercises. Answer sheets may or may not be included.

JOB SHEETS
(Blue pages)

The job sheets provide an introduction, a list of equipment and materials, and a procedure—either an outlined procedure or reference to an appropriate manual containing the procedure—needed for practicing a psychomotor skill. The introduction to the job sheet is new and provides the students with background information necessary to complete the procedure.

The instructor should discuss the introduction to the job sheet, discuss the equipment and materials used—emphasizing the specific available equipment and materials in the shop—and provide the students with demonstrations of the job-sheet procedure prior to having students practice.

Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

PRACTICAL TEST
(Yellow pages)

Practical tests provide the instructor with an instrument with which to evaluate job-sheet competencies. The instructor observes the student performing a job-sheet procedure and then evaluates both the process and the product of the procedure.

WRITTEN TEST
(Yellow pages)

This component provides criterion-referenced evaluation of every information-sheet and assignment-sheet objective listed in the unit of instruction. If objectives have been added, deleted, or modified, appropriate changes should be made on the test. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

The acceptable response on a unit test, 85 percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each individual test item. The final unit grade should be obtained by using both the practical test evaluations and the written test score.

ASSIGNMENT AND WRITTEN TEST ANSWERS
(Pink pages)

Assignment answers and written test answers are designed to assist the instructor in evaluation of student performances.

PAGE NUMBERING

The title of the curriculum guide, the number and title of the unit, and the page number are identified on each page of this curriculum manual. Each unit is page numbered separately. Using this page numbering system, lost or misplaced pages can easily be identified.

DISSEMINATING MATERIAL

Material may be given out a unit or page at a time to keep the material before the student always new. Some instructors ask students to furnish a three-ring binder for the current unit of study. This is convenient for taking the material home to study. Upon completion, each unit is then placed in a larger binder. The large binders may be purchased from the CIMC. Some instructors store the materials by units in filing cabinets or boxes until needed. All the units may be given out at once if desired.

For best results, provide student materials for each student. Student materials contain objective sheets, pretests, information sheets, assignment sheets, activity sheets, job sheets, practical tests, and written tests. All tests are collated at the back of student material and should be removed and stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

It is a challenge to keep students motivated. Instructors should supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

OBJECTIVE SHEET

UNIT 1 SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

INTRODUCTION

If all the systems in an automobile were listed in their order of importance, the brake system would probably head the list. Most drivers have experienced the inconvenience caused by an engine that would not start, and many remember a winter's night when the heating system gave them nothing but cold air. A failure in the hydraulic brake system, however, is much more than a mere inconvenience. Failure in the brake system can cause property damage, serious injury, and even death. The brakes specialist must always remember that the quality of any brake service is measured only in terms of safety.

UNIT OBJECTIVE

After completing this unit, the student should be able to diagnose hydraulic system and wheel bearing problems and service these brake systems. The student will demonstrate these competencies by completing assignment sheets, job sheets, and written test with a minimum of 85 percent accuracy.

PREREQUISITES

Before studying this unit, the student should have successfully completed the core curriculum, *Introduction to Automotive Service*.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to

1. Recognize definitions of terms associated with the brake hydraulic system by choosing the correct definitions from lists of three choices.

2. Recall the basic components of a hydraulic brake system by labeling the names of components shown on an illustration.

3. Recall the steps in hydraulic brake operation by listing the steps in order when given a numbered illustration.

4. Recall characteristics of good brake fluid by writing the characteristics when given a key word or words.

5. Recognize guidelines for handling and storing brake fluid by selecting the correct guidelines from a list.

6. Recall distinguishing characteristics of hydraulic lines and fittings by completing descriptive statements.

7. Determine the correct specialty tool to use to service hydraulic system and wheel bearings by stating the name of the tool when given a service situation.

8. Inspect, test, and service hydraulic brake lines and hoses. (Job Sheet 1)

9. Bleed or flush a hydraulic braking system. (Job Sheet 2)

10. Recall dual braking system designs by completing drawings of hydraulic circuits.

11. Evaluate asbestos safety practices by identifying safety violations in case studies and stating corrective actions.

12. Recognize definitions of terms associated with wheel bearings by matching terms to their correct definitions.

13. Identify types of wheel bearings by writing the correct names for given illustrations.

14. Recall the purposes of wheel bearings by listing their purposes.

15. Recall the parts of a tapered roller wheel bearing assembly by writing the names of components shown on an illustration.

16. Recognize properties of wheel bearing grease by selecting the correct properties from a list.

17. Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals. (Job Sheet 3)

18. Adjust wheel bearings. (Job Sheet 4)

19. Remove and replace front-wheel-drive nonserviceable sealed wheel bearings. (Job Sheet 5)

20. Recall the parts of a typical dual master cylinder by writing the names of components shown on an illustration.
21. Remove and replace a dual master cylinder. (Job Sheet 6)
22. Remove and replace a take-up valve in a quick take-up master cylinder. (Job Sheet 7)
23. Overhaul a master cylinder. (Job Sheet 8)
24. Bench bleed a master cylinder. (Job Sheet 9)
25. Recognize combination valve components and functions by matching components and their functions to an illustration.
26. Remove and replace a combination valve. (Job Sheet 10)
27. Remove, adjust, and replace a load-sensing proportioning valve. (Job Sheet 11)
28. Check and adjust brake stop light and warning light systems. (Job Sheet 12)
29. Diagnose brake system hydraulic and wheel bearing problems. (Assignment Sheet 1)
30. Recognize types of power-assist units by writing the correct names for given illustrations.
31. Recall the major parts of a vacuum power-assist unit by writing the names of components shown in an illustration.
32. Recall the major parts of a hydraulic power-assist unit (mechanical pump) by writing the names of components shown on an illustration.
33. Recall the major parts of a hydraulic power-assist unit (electrical pump) by writing the names of components shown on an illustration.
34. Diagnose power-assist unit problems. (Assignment Sheet 2)
35. Inspect a vacuum power-assist unit and check valve for leaks and proper operation. (Job Sheet 13)
36. Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation. (Job Sheet 14)
37. Test, remove, and install a hydraulic power-assist unit (mechanical pump). (Job Sheet 15)

38. Inspect and overhaul a hydraulic power-assist unit (electrical pump). (Job Sheet 16)

39. Recall functions of major components of a brake antiskid system by matching components to their correct functions.

40. Diagnose an antiskid system and replace faulty components. (Job Sheet 17)

SUGGESTED ACTIVITIES

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section. Include in your selection media that demonstrate job-sheet skills. Videotape your own demonstrations of job-sheet procedures if unable to obtain suitable media.

- Obtain transparencies and competency profiles for this unit.

  NOTE: Transparencies and competency profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

- Prepare classroom and shop. Display posters, charts, safety signs, etc., that emphasize hydraulic brake system and wheel bearing service. Have articles, specification guides, mock-ups, and other references about hydraulic brake and wheel bearing service available for student use. Display various types of DOT brake fluid, wheel bearings, and master cylinders.

- Discuss with students the purpose of pretesting. Explain that they will be asked to complete a written pretest and that they will be required to demonstrate assignment-sheet competencies and job-sheet skills as part of the pretesting process.

- Provide students with equipment and materials necessary to complete pretest. Administer pretest.

- Assess student competencies. Consider results of student assessments of the unit objectives as you prepare your presentation for each objective.

DELIVERY

Unit introduction

- Discuss introduction to the unit (see Objective Sheet).
- Discuss the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives will lead to meeting the unit objective and how reaching the unit objective is vital to becoming an automotive brakes specialist. Also relate the objective to your introduction and to materials previously covered.
- Show film, *Hydraulic Brake Service Overview*. Discuss with class.
- Discuss Supplement 1, "Basic Principles of Braking."
- Use Transparency 1, "Hydraulic Brake System Operation," to illustrate basic hydraulic brake system operation.
- Discuss the importance of accurate diagnosis and high-quality brake service.
- Show the class sample diagnostic charts and service schedules from various service manuals. Post charts and other materials related to brake service.
- Tour the shop and point out the equipment, materials, and areas reserved for brake work.

Objective 1 Recognize definitions of terms associated with the brake hydraulic system

- Show examples of terms where applicable.
- Show samples of the various classes of brake fluids.
- Discuss health-related terms in more detail when you cover Objective 11.
- Have students complete Supplement 3, "Hydraulic System Crossword Puzzle," as a review of terms.

Objective 2 Recall the basic components of a hydraulic brake system

- Show students the actual components on various makes and models of vehicles. Point out differences in types of master cylinders, brake valves, line configurations, and brake types.
- Discuss the functions of each component, pointing out design features that facilitate function.

- Display components on a table in the shop. Encourage students to handle and examine each component.

- Pair students and have teams quiz each other on the names and locations of the components.

- Show media presentations, *Brake Hydraulics* and *Theory of Hydraulics*.

Objective 3 Recall the steps in hydraulic brake operation

- Review hydraulic principles such as Pascal's Law, coefficient of friction, power, energy, force and motion, tire traction, etc. Use Supplement 1, "Basic Principles of Braking," to aid you in your discussion.

- Use Supplement 1 to explain basic principles of braking.

- Build a mock-up to illustrate the sequence of hydraulic brake operation.

- Use Transparency 1, "Hydraulic Brake System Operation," to illustrate your discussion of hydraulic brake operation.

- Show media presentation, *Hydraulic Brake Service Overview*.

Objective 4 Recall characteristics of good brake fluid

- Discuss each of the characteristics listed in this objective.

- Demonstrate applicable properties or characteristics. For example, place a container of brake fluid in the refrigerator and then demonstrate its viscosity or flowability at low temperatures.

- Discuss box material, "Types of Brake Fluid."

- Show students samples of the three types of DOT brake fluid. Discuss the differences in the different types.

Objective 5 Recognize guidelines for handling and storing brake fluid

- Review each of the guidelines listed in this objective, explaining the reasons for each.

- Use a painted piece of scrap metal to demonstrate the effects of spilling brake fluid on a painted surface.

- Discuss the box material, "More About Brake Fluids," explaining its application to the guidelines listed.

- Demonstrate how brake fluid absorbs moisture from the air and how this absorption lowers the boiling point of the fluid. Use three containers of brake fluid: one just opened, one left open to the air overnight, and one left open to the air for one or two days. Carefully heat each container of fluid over an electric burner, measuring the length of time it takes each to boil.

  CAUTION

  Do **not** use an open flame to heat the fluids, and do **not** spill any of the fluid near an electric burner. Brake fluid is flammable. Turn off heat as soon as fluid reaches boiling point.

- Have students read the cautions and instructions for use on the labels of various types of brake fluid.

Objective 6 Recall distinguishing characteristics of hydraulic lines and fittings

- Show students examples of various hydraulic lines and fittings.
- Slice a brake hose lengthwise to expose its plies and to show students how hose fittings are designed to grip both the inside and outside of the hose.
- Display various male and female hose and line fittings.
- Demonstrate installation of both a double flared fitting and an ISO flared fitting, pointing out the similarities and differences between the two.
- Demonstrate the proper tools and methods for removing and installing lines and fittings.
- Combine this with the next objective by showing students how to shape lines with a lever-type tubing bender.

Objective 7 Determine the correct specialty tool to use to service hydraulic system and wheel bearings

- Show students an example of each of the tools listed in this section of the information sheet.
- Demonstrate the use of each of the tools, allowing each student to return the demonstration.
- Where applicable, show students alternative tools or methods that can be used to accomplish a task.
- Show students how to read a pressure gauge and how to read vacuum pressure specification charts in service manuals.

- Show media presentation, "Test the Hydraulic System."

- Discuss the correct use of an inspection report form such as Supplement 4, "Brake System Inspection Report Form," and provide students with copies to use when practicing inspection procedures.

- Discuss equipment and materials used in Job Sheet 1, "Inspect, Test, and Service Hydraulic Brake Lines and Hoses." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 1. Have students practice Job Sheet 1 until they are ready to take the practical test.

- Show media presentation, "Bleed Brake System."

- Discuss equipment and materials used in Job Sheet 2, "Bleed or Flush a Hydraulic Braking System." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 2. Have students practice Job Sheet 2 until they are ready to take the practical test.

Objective 10 Recall dual braking system designs

- Show students examples of both designs on various vehicles.

- Explain the advantages and disadvantages of the two designs.

Objective 11 Evaluate asbestos safety practices

- Provide students with copies of Supplement 2, "Asbestos Fact Sheet," and any updates on this subject. Discuss the supplement in class and hold a question-and-answer session to resolve any student misunderstanding or misconceptions.

  NOTE: The box material with this objective, comes directly from the material presented in Supplement 2, "Asbestos Fact Sheet." If you choose not to provide the students with Supplement 2, discuss this material thoroughly and answer any student questions.

- Show media presentation, *Don't Blow It*.

- Review and explain each asbestos safety practice outlined in this section of the information sheet.

- Show students a HEPA-type vacuum filter.

- Show students an enclosure-type brake cleaner, and demonstrate its installation and use. Emphasize that the installation sequence must be adhered to strictly.

- Follow EPA's asbestos disposal guidelines in your shop, and make sure that each student is aware of these guidelines.

- Post asbestos safety guidelines in your shop and appropriately discipline any student who disregards the guidelines.

- Invite a former automotive service specialist whose health has been damaged by asbestos inhalation to speak to the class on the dangers of asbestos contamination.

- Make sure that your shop environment meets EPA and OSHA regulations regarding equipment and exhaust systems. If you have not already done so, set aside an area in the shop for brake work only. Monitor students carefully and set high safety standards.

- Explain your laundering procedures to the students. Walk them through the complete routine for washing hands, face, and exposed skin and changing clothes at the end of each class period.

Objective 12 Recognize definitions of terms associated with wheel bearings

- Show students examples of each of the terms listed in this objective.

- Demonstrate *bearing end play*, *press fit*, *push fit*, and *preload*.

- Display a complete bearing assembly with the parts named.

- Discuss the box material, "Wheel Bearings."

Objective 13 Identify types of wheel bearings

- Show students samples of each bearing type.

- Discuss the similarities and differences in bearing types and the reason for manufacturers using one type over another.

- Display the various bearing types on a table in the shop or classroom.

- Combine this objective with Objective 14, and discuss the purposes of wheel bearings as you show the students the different types.

Objective 14 Recall the purposes of wheel bearings

- Combine this objective with Objective 13, explaining the purposes of each type of wheel bearing given.

- Demonstrate how wheel bearings reduce friction. Show students how much resistance there is when sliding a heavy object across a surface compared to sliding the same object across the surface on a handful of marbles.

- Discuss the box material, "Wheel Bearings and Load Lines."

Objective 15 Recall the parts of a tapered roller wheel bearing assembly

- Use Transparency 2, "Tapered Roller Wheel Bearing," to illustrate your discussion.

- Display a tapered roller wheel bearing assembly so that students may examine its components.

- Disassemble a tapered roller wheel bearing assembly, naming and explaining each of the parts as it is disassembled.

- Discuss the box material, "Wheel Bearing Noises."

Objective 16 Recognize properties of wheel bearing grease

- Review each of the properties listed in this objective, explaining the reasons for these properties.

- Have students read the labels on various brands of wheel bearing grease. Discuss.

- Demonstrate each of the properties. For instance, show how wheel bearing grease is heat-resistant, water-resistant, and noncorrosive.

- Discuss the box material, "Wheel Bearing Lubrication."

- Show media presentations, "Clean and Inspect Bearings," "Pack Front-Wheel Bearing Assembly," and "Adjust Front-Wheel Bearings."

- Discuss equipment and materials used in Job Sheets 3 through 5. Review with students applicable safety rules and precautions and the guidelines given in each job-sheet introduction.

- Demonstrate Job Sheets 3 through 5. Have students practice Job Sheets 3 through 5 until they are ready to take the practical tests.

Objective 20 Recall the parts of a typical dual master cylinder

- Show students examples of various types of dual master cylinders.
- Disassemble a typical master cylinder, naming and explaining the parts as it is disassembled.
- Discuss the functions of each of the parts of a typical master cylinder, and explain the differences in reservoir size and design.
- Show media presentations, "Remove, Repair, and Replace Tandem Master Cylinder" and *Rebuilding a Dual Piston Master Cylinder*.
- Discuss equipment and materials used in Job Sheets 6 through 9. Review with students applicable safety rules and precautions and the guidelines given in each job-sheet introduction.
- Demonstrate Job Sheets 6 through 9. Have students practice Job Sheets 6 through 9 until they are ready to take the practical tests.

Objective 25 Recognize combination valve components and functions

- Show students an example of a combination valve, pointing out each component and explaining its function.
- Show students the location of the combination valve on various makes and models of vehicles.
- Show students a vehicle that does not combine the brake valves in one unit. Make sure that students can identify each valve.
- Discuss the box material, "Functions of the Combination Valve."
- Use Transparencies 3 through 5 to illustrate your discussion of valve operation.
- Show media presentation, *Hydraulic Brake Service Overview*. Use Transparency 6, "Stop Light Switch Designs," Supplement 5, "Warning Light Switch Operation," and Student Supplement 8, "Diagnostic Chart for Stop Lights," to assist you in discussing warning and stop light switch operation.
- Discuss equipment and materials used in Job Sheets 10 through 12. Review with students applicable safety rules and precautions and the guidelines given in each job-sheet introduction.

- Demonstrate Job Sheets 10 through 12. Have students practice Job Sheets 10 through 12 until they are ready to take the practical tests.

- Have students complete Assignment Sheet 1, "Diagnose Brake System Hydraulic and Wheel Bearing Problems."

Objective 30 Recognize types of power-assist units

- Discuss power-assisted braking in general, tracing the evolution of this system, and explaining the need for power-assisted braking on larger and heavier vehicles.

- Show students examples of each type of power-assist unit on various makes and models of vehicles.

- Discuss the differences in design and operation among the units.

Objective 31 Recall the major parts of a vacuum power-assist unit

- Use Transparency 7, "Operation of Vacuum-Suspended Power-Assist Unit," to explain the operation of this type of power-assist unit.

- Show students a vacuum power-assist unit on a vehicle, pointing out and explaining its components.

- Display a mock-up or cutaway vacuum power-assist unit, so that students may examine the internal components of the unit.

- Disassemble a vacuum power-assist unit, explaining each component and its function as you come to it.

- Discuss equipment and materials used in Job Sheet 13, "Inspect a Vacuum Power-Assist Unit and Check Valve for Leaks and Proper Operation." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 13. Show video presentation, "Test Vacuum Booster." Have students practice Job Sheet 13 until they are ready to take the practical test.

Objective 32 Recall the major parts of a hydraulic power-assist unit (mechanical pump)

- Use Transparency 8, "Operation of Hydraulic Power-Assist Unit (Mechanical Pump)," to explain the operation of this type of power-assist unit.

- Show students a hydraulic power-assist unit (mechanical pump) on a vehicle, pointing out and explaining its components. Show students units with both integral and separate accumulators.

- Display a mock-up or a cutaway hydraulic power-assist unit (mechanical pump), so that students may examine the internal components of the unit.

- Disassemble a hydraulic power-assist unit, explaining each component and its function as you come to it.

- Discuss equipment and materials used in Job Sheet 14, "Inspect a Hydraulic Power-Assist Unit (Mechanical Pump) for Leaks and Proper Operation," and in Job Sheet 15, "Test, Remove, and Install a Hydraulic Power-Assist Unit (Mechanical Pump)." Review with students applicable safety rules and precautions and the guidelines given in each job-sheet introduction.

- Demonstrate Job Sheets 14 and 15. Have students practice Job Sheets 14 and 15 until they are ready to take the practical tests.

Objective 33 Recall the major parts of a hydraulic power-assist unit (electrical pump)

- Use Transparency 9, "Operation of Hydraulic Power-Assist Unit (Electrical Pump)," to assist you in explaining the operation of this type of power-assist unit.

- Show students a hydraulic power-assist unit (electrical pump) on a vehicle, pointing out and explaining its components.

- Display a mock-up or cutaway hydraulic power-assist unit (electrical pump), so that students may examine the internal components of the unit.

- Disassemble a hydraulic power-assist unit (electrical pump), explaining each component and its function as you come to it.

- Discuss equipment and materials used in Job Sheet 16, "Inspect and Overhaul a Hydraulic Power-Assist Unit (Electrical Pump)." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 16. Have students practice Job Sheet 16 until they are ready to take the practical test.

- Have students complete Assignment Sheet 2, "Diagnose Power-Assist Unit Problems." Critique and discuss in class.

Objective 39 Recall functions of major components of a brake antiskid system

- Show students the location and components of a brake antiskid system on a vehicle.

- Discuss the functions of each of the antiskid components. Use Transparency 10, "Typical Antiskid System Components," to assist you in your explanation.

- Caution students about performing service on a vehicle equipped with such a system without first reading service manual instructions. Some service techniques, such as bleeding, may require modification.

- Discuss equipment and materials used in Job Sheet 17, "Diagnose an Antiskid System and Replace Faulty Components." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 17. Have students practice Job Sheet 17 until they are ready to take the practical test.

Unit summary activity

- Discuss Activity Sheet 1, "Answer General Questions About Brake Hydraulic System and Wheel Bearings." The purpose of the activity is to provide students with the opportunity to practice answering questions similar in content and style to those found on the actual ASE certification test. Keep this in mind when discussing the assignment.

- Have students complete Activity Sheet 1.

EVALUATION

- Give written test.

- Give practical tests, providing students with copies of Supplement 4, "Brake System Inspection Report Form," or similar form to be completed as part of the practical tests. Evaluate tests on forms provided.

- Reteach and retest as required.

- Complete appropriate section of competency profiles.

SUGGESTED RESOURCES

Resources used in developing unit

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 2: Front Disc Brake Service.* Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual*. Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.
- Billiet, Walter E., and Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.
- *Brake Systems: Student Reference Book*. Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1984.
- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985*. Radnor, Pennsylvania: Chilton Book Company, 1984.
- Coghlan, David A. *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed. Boston: Breton Publishers, A Division of Wadsworth, Inc., 1985.
- Crouse, William H., and Donald L. Anglin. *Automotive Mechanics*, 9th ed. New York: Gregg Division, McGraw-Hill Book Company, 1985.
- Duffy, James E. *Modern Automotive Mechanics*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1985.
- *Guidance for Preventing Asbestos Disease Among Auto Mechanics*. Washington: United States Environmental Protection Agency, June 1986, reprinted by Clayton, Farmingdale, New Jersey.
- Henderson, Chuck, and Ivan Armstrong. *Auto Mechanics I*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

- Hughes, James G. *Guide to Automobile Certification Examination*, revised ed. Reston, Virginia: Reston Publishing Company, Inc., a Prentice-Hall Company, 1983.
- deKryger, William J., Robert T. Kovacik, and Saverio G. Bono. *Auto Mechanics: Theory and Service*. Cincinnati, Ohio: South-Western Publishing Co., 1986.
- *Mitchell Chassis Service & Repair Domestic Cars: 1985 Supplement*. San Diego, California: Mitchell Information Services, Inc., a Cordura Company, 1985.
- Mitchell Information Services, Inc. *Mitchell Automechanics*. Englewood Cliffs, New Jersey: Prentice-Hall, 1986.
- *1985 Bonneville, Parisienne and Grand Prix Preliminary Service Manual*. Pontiac, Michigan: General Motors Corporation, Pontiac Motor Division, 1984.
- *1986 Chrysler Engine-Chassis-Body Service Manual: 1986 Front Wheel Drive Passenger Vehicles Lancer, Daytona, New Yorker, Dodge 600, Aries, Omni, LeBaron GTS, Laser, LeBaron, Caravelle, Reliant, Horizon*. Centerline, Michigan: Chrysler Corporation, 1985.
- *1986 New Model Highlights and Service Features: Domestic and Import*. Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1985.
- *1986 Shop Manual: Caprice, Monte Carlo, El Camino*. Detroit, Michigan: General Motors Corporation, Chevrolet Motor Division, 1985.
- *Raybestos Brake Service Manual for Passenger Cars: Drum and Disc Brakes*. Bridgeport, Connecticut: Division of Raybestos Manhattan, 1970.
- Remling, John. *Brakes*, 2nd ed. New York: John Wiley and Sons, Inc., 1978.
- Stockel, Martin W., and Martin T. Stockel. *Auto Mechanics Fundamentals*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1982.
- Toboldt, William K., and Larry Johnson. *Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1983.

- *Wagner Manual AU-1600/Feb., 1984: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual.* Parsippany, New Jersey: Wagner Division, McGraw-Edison Company, 1984.

Media

- *Theory of Hydraulics.* Slide/tape, 15 minutes. Dana Corporation, School Assistance Program, P.O. Box 455, Toledo, Ohio 43629. This program describes the concepts of flow, pressure, and force in a hydraulic system.

- *Brake Hydraulics* (AU-911). 83 slides with a 15-minute audiotape. Wagner Division, McGraw-Edison Company, 6400 Plymouth Avenue, St. Louis, Missouri 63133. This program explains how hydraulics is used in both drum and disc brake systems.

- *Hydraulic Brake Service Overview.* 12 minutes, color filmstrip and cassette. Prentice-Hall Media, ServCode DU, 150 White Plains Road, Tarrytown, New York 10591. This filmstrip shows the components of a typical hydraulic brake system, explains the operation of the system, and discusses some recommended safety checks. The filmstrip also discusses the combination valve in some detail.

- *Rebuilding a Dual Piston Master Cylinder.* 14 minutes, color filmstrip and cassette. Prentice-Hall Media, ServCode DU, 150 White Plains Road, Tarrytown, New York 10591. This filmstrip identifies components and their functions, shows how they are removed and replaced, and includes overhauling procedures.

NOTE: The following two videotapes are available to Oklahoma teachers on a free-loan basis. Out-of-state teachers must order from the addresses listed.

- *Service Brake Hydraulic System and Wheel Bearings* containing the following: "Test the Hydraulic System"; "Bleed Brake System"; "Clean and Inspect Bearings"; "Pack Front-Wheel Bearing Assembly"; "Adjust Front-Wheel Bearings"; "Remove, Repair, and Replace Tandem Master Cylinder"; and "Test Vacuum Booster." VHS videotapes. Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

- *Don't Blow It.* 16 minutes, VHS videotape. Available for loan or purchase from Clayton Associates, Inc., P.O. Box 589, Farmingdale, New Jersey 07727-0589, phone (800) 248-8650. This videotape demonstrates the proper way to use asbestos-removal equipment to prevent asbestos exposure.

Print media

For the most recent information on asbestos safety for the brakes specialist, write to the following addresses:

- EPA Region VI
  Internfirst II Bldg.
  1201 Elm Street
  Dallas, Texas 75270
  (214) 767-2734

- National Institute for Occupational Safety and Health
  4676 Columbia Parkway
  Cincinnati, Ohio 45226
  (513) 533-8323

- OSHA Office of Information and Consumer Affairs,
  Rm N-3637
  200 Constitution Avenue N.W.
  Washington, D.C. 20210
  (202) 523-8151

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 1

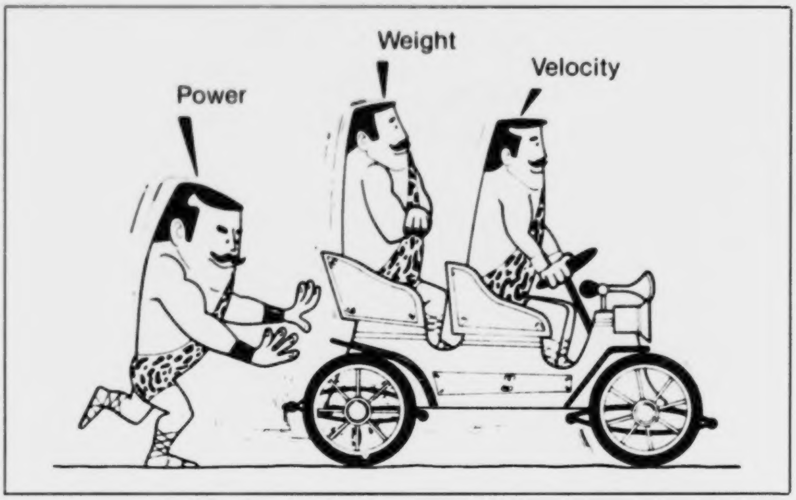
Basic Principles of Braking

ENERGY

It takes energy to operate your car. Energy can be defined as the ability to do work. People cannot produce energy, but they can change it from one form to another.

When you use gasoline as a fuel for your car, the energy in it is converted to power by the car's engine. The engine produces this conversion by burning the gasoline and using the released heat energy to turn a crankshaft. This motion is passed on to the wheels, which turn and move the car.

A car is kept in motion by two forces. One of those forces is the power that started the car moving, and the second force is the weight and velocity—or speed—of the car. The combination of these two forces is called *kinetic energy*.



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The heavier the vehicle and the faster it is moving, the more kinetic energy the vehicle has, and therefore, the harder it is to stop. In fact, a car in motion would never stop unless it was made to do so by another force. That force must eliminate the kinetic energy. The brake system provides that other force.

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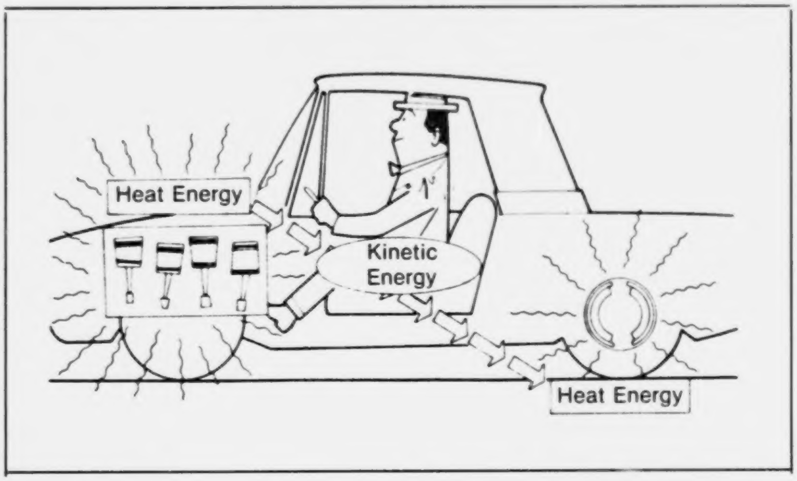
Just as energy cannot be produced, it also cannot be destroyed. The brake system, however, changes the kinetic energy of a moving car to another form of energy. Kinetic energy was obtained by releasing heat energy in the engine. The best way to stop a car is to change the kinetic energy back to heat energy.



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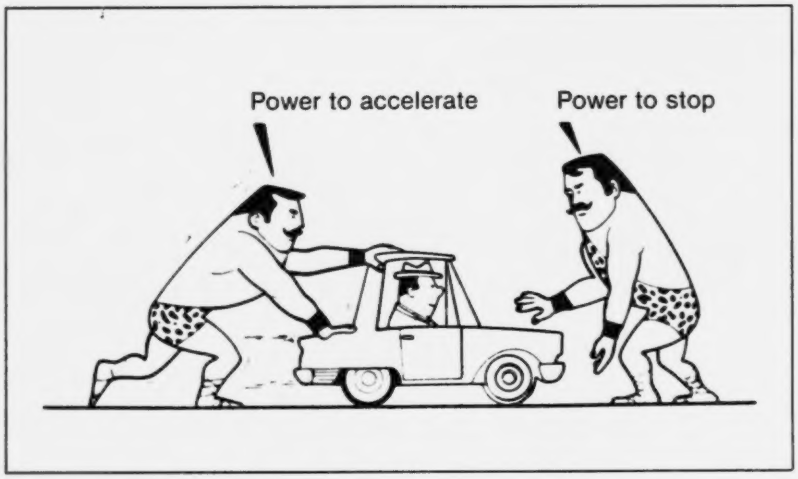
POWER

While many people are concerned with the power developed by an engine, very few consider the power required of the braking system. As shown below, it takes power to accelerate a car and it takes power to bring it to a stop.



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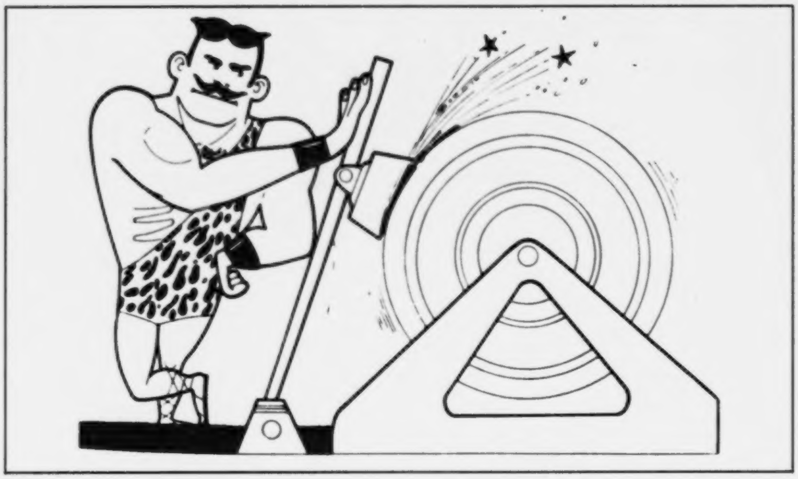
If power is thought of as the time required to convert energy, then the brake system must be capable of delivering from two to three times the power of the engine. The brake system does this through the use of friction.

FRICTION

Friction is the resistance to motion that exists between two objects in contact. There are many types of friction, but the dry, sliding type provides the greatest resistance to motion.

Friction creates heat. You have probably found that you can warm your hands by rubbing them together. The rubbing changes the kinetic energy of your moving hands to heat energy. This change is caused by friction. Heat is produced when a brake shoe is applied to a rotating wheel. The friction between the brake shoe and the wheel converts the kinetic energy of the moving wheel to heat energy, and brings the wheels and therefore the car to a stop.



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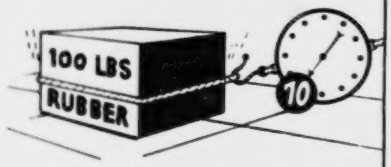
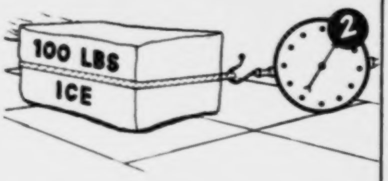
COEFFICIENT OF FRICTION

Differences in the amount of friction can be measured and are called *coefficients of friction*. For instance, the coefficient of friction between rubber-soled shoes and the floor is greater than the coefficient of friction between leather-soled shoes and the floor. The coefficient of friction of any two objects can be determined mathematically. As shown on the following page, the amount of pulling effort is divided by the weight of the load (the force holding the two objects together).

	70 ÷ 100 = 0.70
	2 ÷ 100 = 0.20

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The two objects in contact in a brake system are the brake shoes and the drum or disc. Therefore, the friction in a brake system depends not only on the driver's force in applying the brakes, but also on the materials used to make the shoes and the drums or disc.

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 2

Asbestos Fact Sheet

PREVENTING ASBESTOS DISEASE AMONG AUTO MECHANICS

I. MECHANICS' EXPOSURE TO ASBESTOS:

Friction materials, such as brake linings and clutch facings, often contain asbestos. Millions of asbestos fibers can be released during brake and clutch servicing (*Ref. 1-8*). Grinding and beveling friction products can cause even higher exposures (*Ref. 1-8*). Like germs, asbestos fibers are small enough to be invisible, and they can remain and accumulate in the lungs. When you see a dust cloud during brake work, you are seeing clumps containing thousands of fibers. Most of the smaller fibers will not show up with the methods commonly used for measuring asbestos levels in the air, such as the method used to determine compliance with the OSHA asbestos standard, since most asbestos fibers in brake dust are too small to be measured by these methods (*Ref. 1-3, 5-8*).

Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed in by everyone inside the garage, including customers. While lowering exposure lowers risk, there is no known level of exposure to asbestos below which health effects do not occur (*Ref. 9-12*). The EPA has proposed phasing out the use of asbestos products. In situations where asbestos exposures cannot be eliminated entirely, they should be reduced to the lowest possible level (*Ref. 9, 13*).

Asbestos can be carried on work clothing, contaminating the family car and home. This can cause asbestos disease among family members. An ordinary house vacuum cleaner cannot collect these asbestos fibers, since its filter is not fine enough to trap them. In fact, an ordinary house vacuum cleaner is likely to stir these fibers up and scatter them into the air.

Asbestos can also get on a mechanic's hands and be swallowed when eating or smoking a cigarette. This is a particularly difficult problem for mechanics, since they often get grease on their hands and asbestos fibers can stick to the grease.

II. HEALTH EFFECTS OF ASBESTOS EXPOSURE:

Until the use of asbestos products is phased out, the best way of limiting health damage to workers exposed to asbestos is to use proper controls. It is not possible to predict whether an individual person exposed to asbestos will later develop asbestos-related disease. But studies of disease patterns among large groups of workers exposed to asbestos make general observations possible. The following can be the consequences of inadequate prevention:

Asbestosis

Asbestos exposure can cause scar tissue to form in the lungs. This is a very gradual process that usually takes many years before its effects are noticed. This scarring is called *asbestosis*. It causes gradually increasing shortness of breath. A person with this disease must breathe harder and deeper to get his or her breath because the scar tissue makes it harder for oxygen to get into the blood stream. This scarring is caused by repeated exposures to asbestos and is permanent. Nearly one-half of the mechanics who work for many years without proper control measures can develop this scarring (*Ref. 7, 14*).

Cancer

1. Mesothelioma

   Mesothelioma is a type of fatal cancer of the lining of the chest or abdominal cavity. It can be caused by very low exposures to asbestos. This cancer has occurred among brake mechanics (*Ref. 15-20*), their wives (*Ref. 20*), and their children (*Ref. 21*).

2. Lung Cancer

   Lung cancer is currently responsible for the largest number of deaths from exposure to asbestos (*Ref. 22*). Even short-term occupational exposures have been shown to increase the risk of lung cancer. Like asbestos, smoking can independently cause lung cancer, increasing the risk by about 10 times. When smokers are exposed to asbestos, the risks do more than add together; they actually multiply. For example, asbestos insulators who smoke have a lung cancer risk over 50 times higher than nonsmokers without asbestos exposure. However, stopping smoking greatly reduces this risk, even if a person has smoked for many years. Smokers who have been exposed to asbestos should be especially encouraged to stop smoking. The extent of risk of lung cancer among mechanics is not now known; but, given the known lung cancer risk among other groups exposed to asbestos, caution is necessary.

3. Other Cancers

   Other cancers which appear to be caused by asbestos include cancer of the voice box (*Ref. 25, 26*) and of the stomach and large intestine (*Ref. 27, especially page 315*).

Latency Period

It usually takes 15 to 30 years or more for cancer or asbestos lung scarring to show up after exposure. (Scientists call this the *latency period.*) Until then, the victim often feels fine. This gives a false sense of security. For example, if one touches a hot stove, one gets burned right away. With asbestos, the damage isn't obvious until many years later. This false sense of security can easily lead a worker and/or supervisor to follow work practices that can cause harmful exposures, since they are not aware that disease may develop later.

III. MEDICAL TESTS:

Medical tests only discover asbestos-related disease after it has developed. In some cases, where the condition may be curable, especially with asbestos-related cancers of the large intestine and voice box, early detection can be very important.

Asbestosis

Asbestosis, or lung scarring from asbestos, is permanent and cannot be treated. It is diagnosed by chest X rays, breathing tests (called *lung* or *pulmonary function tests*), and/or listening to the lungs, together with a history of exposure to asbestos. Very early asbestosis may be missed by these techniques. Early asbestosis is difficult to see on a chest X ray and is best evaluated by a doctor who has experience and/or specialized training with asbestosis. (This type of specialist is called a "B reader" of X rays.)

Lung Cancer

Very often lung cancer from asbestos has already spread by the time it can be seen on a chest X ray or by tests of the phlegm. This is why more frequent tests for lung cancer do not help the average person who develops this cancer to live longer. Lung cancer is thus a condition needing prevention more than early detection and cure.

Intestinal Cancer

Cancer of the large intestine can often be detected early by yearly exams of the rectum and sigmoid area, with a hemoccult test for blood in the stool. Early detection and treatment of this condition can result in cure.

Voice Box Cancer

Voice box cancer can often be discovered at a curable stage by a medical exam. It may show up as hoarseness that does not go away in a few weeks.

IV. EXTENT OF EXPOSURE DURING BRAKE/CLUTCH MAINTENANCE:

Using a compressed-air hose to clean drum brakes can release up to 16 million asbestos fibers in the cubic meter of air around a mechanic's face (*Ref. 1*).* Even hitting a brake drum with a hammer can release over a million asbestos fibers (*Ref. 4*). Much less dust from asbestos-lined disc brake pads will settle on disc brakes, but some dust can get on a mechanic's hands and into the garage air during maintenance. The asbestos fibers released from brake and clutch work can be scattered throughout a garage, where they can present a hazard for months or years. Because of this, many garages are now turning to newer methods for brake cleaning. However, some of these newer methods may actually contribute to the problem. For example, millions of asbestos fibers can be released from drum brakes with these methods:

- Wiping with a dry rag or brush (*Ref. 1-3*).
- Wiping with a wet rag or brush (*Ref. 2, 3*). The water doesn't prevent scattering of much of the asbestos, and when the rag dries or is shaken, asbestos is spread around the garage.
- Liquid squirt bottles or solvent sprays (*Ref. 3*). The water or solvent under pressure scatters much of the asbestos, and when it dries the asbestos is still all over the surrounding work surfaces. Brake-cleaning equipment using these methods with a brush or squirt gun is likely to have the same problems. In fact, measurements from one manufacturer using a liquid spray system showed that over a million fibers can be released near a mechanic's face (*Ref. 28*). Using a specially designed low-pressure spray and properly collecting and disposing of contaminated liquid may prevent some asbestos from spreading around the garage. Some recirculating wet-method equipment uses a solvent to collect brake dust into a tray. If the solvent evaporates from the tray, normal air currents easily lift the asbestos fibers back into the air.
- Using a garden hose may prevent some brake dust from becoming airborne, but this can easily contaminate the garage floor or other work areas by scattering the asbestos.
- Using a standard shop vacuum cleaner. A shop vacuum cleaner can spread asbestos about a garage as much as does a compressed-air hose (*Ref. 6: Using a shop vacuum cleaner raised asbestos concentrations in adjacent bays to levels greater than those found using a compressed-air hose.*). A shop vacuum cleaner filter is not fine enough to collect asbestos fibers.

* These are the larger fibers measured by common methods for counting asbestos fibers. The very small ones are far more numerous, but can be seen with the electron microscope.

All of these brake-cleaning methods can release enough asbestos into a garage (*Ref. 6, 29*) so that an average of over one million of the larger fibers could be breathed each day by workers in that garage. These brake-cleaning methods can also cause customers to be exposed, since asbestos from brake work can be spread 75 feet away from the mechanic (*Ref. 1*).

When grinding is done to renew used brake block linings, concentrations of up to 7 million asbestos fibers per cubic meter can be released. Bevelling new linings can release concentrations of up to 72 million fibers and light grinding of new linings of up to 4.8 million fibers (*Ref. 7*).

V. CONTROLLING EXPOSURES:

NIOSH, OSHA, and EPA recommend that where asbestos exposures cannot be eliminated, they must be controlled to the lowest level possible (*Ref. 9, 13*). Effective containment prevents problems associated with housekeeping and with stirring up settled dust (*Ref. 13*). The best approach is to contain brake dust and prevent its release into a garage.

Brake Cleaning

Enclosure equipment for brake cleaning is available, which slips easily over the brake assembly and forms a tight seal against the backing plate. A compressed-air system can then be used inside this type of enclosure system for good brake cleaning without exposing the brake mechanic or others. Clear plastic walls or windows allow easy visibility of the work being done. Brake dust is sucked into a vacuum cleaner equipped with a special filter called a HEPA or "high-efficiency particulate air" filter. Only this type of filter can capture the small, invisible asbestos fibers. Nonpermeable glove attachments on some equipment allow a mechanic to do work inside the enclosure without getting asbestos on the hands. If glove attachments are available only as an option, this option should be selected.

How To Use Enclosure Equipment for Cleaning Drum Brakes

Steps for using this type of equipment on drum brakes are simple:

1. Check that the hose is securely fastened to the HEPA vacuum container and to the brake enclosure. Also check that the vacuum container seals and clips are in proper functioning order according to the manufacturer's instructions.
2. Remove the wheel.
3. Turn on the asbestos vacuum cleaner.
4. Place the enclosure over the drum, making sure it forms a tight seal behind the backing plate.
5. Place hands into the attached rubber gloves.

6. Remove the brake drum. Some equipment allows use of a hammer or other tools inside the enclosure for drums that are hard to remove.
7. Blow dust off the drum and brake assembly, using the air gun attachment inside the enclosure.
8. Blow dust off all inside surfaces of the enclosure towards the vacuum exit, using the air gun attachment inside the enclosure.
9. Remove the enclosure and turn off the vacuum cleaner.

If grease accumulates on the inside surfaces of the enclosure, clean according to the manufacturer's instructions with a soft cloth and with the vacuum running. Dispose of the cloth according to OSHA regulations (*Ref. 30*). This cloth should not be handled with bare hands.

Disc Brakes

For disc brakes, vacuum the pads, rotor, and caliper directly with a crevice attachment and avoid handling them before vacuuming.

Filter Change and Waste Disposal

Asbestos vacuum cleaners have several filters. Changing filters and disposing of asbestos waste can release dangerous concentrations of asbestos unless done properly. Some equipment allows for filter or collection bag change while the vacuum motor is running. This draws loose brake dust into the vacuum collector and away from the mechanic, reducing the risk of exposure. Some equipment has a renewable main filter that can be cleaned repeatedly without opening the vacuum cleaner. Ideally, all vacuum equipment should be designed to prevent opening the vacuum chamber when the vacuum motor is turned off, since opening the chamber can cause release of collected asbestos into the air. Always follow the manufacturer's instructions for filter or collection bag change. Request a demonstration and practice session from the manufacturer to go through all steps for equipment use and filter or collection bag change, until each person who is to use this equipment is completely familiar with these procedures. Place the filter or collection bag directly into a 6-mil. (heavy) plastic bag and double tie. Place the bag directly into a 55-gallon drum or similar leakproof, airtight container designated for asbestos waste according to OSHA regulations (*Ref. 30*) and mark it as follows:

CAUTION
Contains Asbestos Fibers
Avoid Breathing Dust
Breathing Asbestos Dust Can Cause Lung Disease and Cancer

Keep this drum for asbestos waste locked between filter or collection bag changes. Transport and disposal of asbestos waste should be done only by individuals familiar with procedures for handling asbestos waste in accordance with EPA's asbestos-disposal guidance (*Ref. 31*).

Clutch Repair

Significant exposure can also occur during clutch repair. Since a mechanic's head is typically under the clutch assembly during clutch repair, asbestos often falls on a mechanic's face and clothing. Enclosure equipment with a HEPA vacuum cleaner to prevent this exposure is under development.

Non-Asbestos Brake Linings

The use of non-asbestos friction materials is increasing. Available information suggests that none of these substitute materials is as dangerous as asbestos. Unless a mechanic is certain before brake work starts that a particular vehicle's brakes are not lined with asbestos, it should be assumed for the sake of caution that there is asbestos in the brake dust. In addition, friction materials often contain adhesives, toxic metals, and other hazardous chemicals that can harm the body (*Ref. 2*). Thus, even for non-asbestos friction products, an enclosure system can control exposures to materials that may be harmful.

What To Look for in Enclosure Equipment for Brake Cleaning

Recommended features to look for in selecting enclosure equipment include:

1. Features which prevent hand contact with asbestos, including rubber (or other non-permeable) gloves to cover both hands. Look for attached gloves with no spaces for leakage. If attached gloves are not standard with the equipment, they should be selected as an option.
2. Enclosures large enough to fit around the biggest size brake drums likely to be encountered to prevent exposure during drum removal.
3. Reports of air sampling with analysis by transmission electron microscopy that show no release of asbestos fibers when using the equipment during brake maintenance. This helps ensure against design defects.
4. A sturdy seal behind the backing plate to prevent leakage during blow out.
5. A pressure gauge or manometer indicating when vacuum filter change or cleaning of renewable filter is needed. This helps ensure effective suction during use.
6. Safety of filter change or renewable filter cleaning. Ideally, future models of these devices will have a feature that prevents opening the filter housing while the vacuum motor is switched off.

Enclosure system manufacturer information is discussed in *References 32-35.*

Machining and Bevelling

Whenever possible, pre-ground, installation-ready brake linings and clutch facings should be used. If friction materials must be arced, this should be done by lathe-turning at low speed, rather than by grinding. Linings should not be ground to fit brake systems for which they were not designed. Where friction materials must be machined, bevelled, or lathe-turned, adequate local exhaust ventilation equipment connected to a HEPA vacuum collector should be used to prevent mechanic exposure and shop contamination. Such equipment should be designed and set up by a professional ventilation engineer, using specifications such as those found in the American Conference of Governmental Industrial Hygienists' ventilation manual (*Ref. 36*) as a minimum design standard. There must be a comprehensive asbestos control and monitoring program where machining, bevelling, or lathe-turning is done (*Ref. 30*).

Special Areas for Brake Work

Eating, drinking, and smoking should not be done in an area where brake work is done. Mechanics should wash their hands and face before eating and wash all exposed skin and change clothes before going home. If possible, work clothes should be laundered at special facilities equipped to wash clothing contaminated with asbestos. Smokers should be urged to quit and, if necessary, be provided assistance in entering a smoking-cessation program.

VI. RESPIRATORS:

The National Institute for Occupational Safety and Health (NIOSH) recommends the use of engineering controls and good work practices as the primary means of reducing exposures (*Ref. 9, 13*). Proper use of a respirator specially recommended for asbestos (*Ref. 37*) when using the brake-cleaning methods described in Part IV of this guidance can only protect a mechanic while the respirator is being worn. Since any of the brake-cleaning methods described in Part IV could contaminate a garage with brake dust, mechanics and other employees would have to wear such a respirator all day to be protected. In addition, effective respirator use requires use requires a complete respiratory protection program, including worker training, medical evaluations, proper respirator selection and maintenance, fit testing, and periodic inspections. Furthermore, NIOSH and EPA recommend only certain air-supplied respirators for asbestos exposure (*Ref. 37*). These respirators could be very cumbersome in a garage setting.

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Air-purifying respirators with HEPA cartridges may be appropriate for secondary protection during floor cleaning, filter or collection bag changing, and waste disposal. Air-purifying respirators with HEPA cartridges should be used only as a precaution against the accidental disturbance of asbestos, and not as a substitute for effective engineering controls. It should be noted that, while NIOSH and EPA do not recommend the use of air-purifying respirators with HEPA cartridges in asbestos environments, various existing regulations currently allow their use.

REFERENCES

1. Rohl, A.N., Langer, A.M., Wolff, M.S., and Weisman, I. Asbestos Exposure during Brake Lining Maintenance and Repair. Environmental Research 12:110-128. 1976.
2. NIOSH. Report 32.4 Industrial Hygiene Summary Report of Asbestos Exposure Assessment for Brake Mechanics. November 22, 1982.
3. PEI Associates. Asbestos Dust Control in Brake Maintenance. EPA Office of Pesticides and Toxic Substances Contract No. 68-02-3976. September 30, 1985.
4. GCA Corporation. Asbestos Product Test Results. EPA Office of Pesticides and Toxic Substances Contract No. 68-02-3168. February 1980.
5. Hatch, D. Possible Alternatives to Asbestos as a Friction Material. Annals of Occupational Hygiene 13:25-29. 1970.
6. Knight, K.L. and Hickish, D.E. Investigations and Alternative Forms of Control for Dust Generated during Cleaning of Brake Assemblies and Drums. Annals of Occupational Hygiene 13:37-39. 1970.
7. Lorimer, W.V., Rohl, A.N., Miller, A., Nicholson, W.J., and Selikoff, I.J. Asbestos Exposure of Brake Repair Workers in the United States. Mount Sinai Journal of Medicine 43:207-218. 1976.
8. Rohl, A.N., Langer, A.M., Klimentidis, R., Wolff, M.S., and Selikoff, I.J. Asbestos Content of Dust Encountered in Brake Maintenance and Repair. Proceeding of the Royal Society of Medicine 70:32-37. 1977.
9. NIOSH-OSHA Asbestos Work Group. Workplace Exposure to Asbestos: Review and Recommendations. DHHS (NIOSH) Publication No. 81-103. November 1980.
10. OSHA. Occupational Exposure to Asbestos: Emergency Temporary Standard. Federal Register Vol. 48, No. 215. November 4, 1983.
11. National Research Council. Asbestiform Fibers: Nonoccupational Health Risks. National Academy Press. 1984.
12. Chronic Hazard Advisory Panel on Asbestos. Report to the U.S. Consumer Product Safety Commission. July 1983.

13. NIOSH. Statement of the National Institute for Occupational Safety and Health. Public Hearing on Occupational Exposure to Asbestos. June 21, 1984.
14. Nicholson, W.J. Investigation of Health Hazards in Brake Lining Repair and Maintenance Workers Occupationally Exposed to Asbestos. NIOSH Contract No. 210-77-0119. February 1983.
15. McDonald, A.D., Harper, A., El Attar, O.A., and McDonald, J.C. Epidemiology of Primary Malignant Mesothelial Tumors in Canada. Cancer 26:914-919. 1970.
16. Greenburg. M. and Lloyd Davies, T.A. Mesothelioma Register 1967-68. British Journal of Industrial Medicine 31:91-104. 1974.
17. Newhouse, M.L. and Thompson, H. Mesothelioma of the Pleura following Exposure to Asbestos. British Journal of Industrial Medicine 22:261-269. 1965. (Table on p. 269, case #58.)
18. NIOSH. Asbestos: Asbestos Exposure during Servicing of Motor Vehicle Brake and Clutch Assemblies. Current Intelligence Bulletin 5. August 8, 1985.
19. Langer, A.M. and McCaughey, W.T.E. Mesothelioma in a Brake Repair Worker. Lancet 8307:1101-1103 November 13, 1983.
20. Ziem. G. Three case reports of mesothelioma in brake mechanics. In: Castleman, B. Asbestos: Medical and Legal Aspects. Harcourt Brace Jovanovich. 1984. (Four additional cases in mechanics and a case in a mechanic's wife in publication.)
21. Yorkshire Television. "Alice: A Fight for Life." July 14, 1982. (Mesothelioma in a ten-year-old son of brake mechanic described and filmed.)
22. EPA. Asbestos; Proposed Mining and Import Restrictions and Proposed Manufacturing Importation and Processing Prohibitions. Federal Register Vol. 51, No. 19. January 29, 1986.
23. Seidman, H., Selikoff, I.J., and Hammond, E.C. Short-term Exposure to Asbestos and Long-term Observation. Annals of the New York Academy of Sciences 330:61-90. 1979.
24. EPA. Support Document for Final Rule on Friable Asbestos-Containing Materials in School Buildings: Health Effects and Magnitude of Exposure. January 1982.
25. Stell, P.M. and McGill, T. Asbestos and Laryngeal Cancer. Lancet 7826:416-417. August 25, 1973.
26. Shettigara, P.T. and Morgan, R.W. Asbestos, Smoking and Laryngeal Carcinoma. Archives of Environmental Health 30:517-519. 1975.
27. Selikoff, I.J. and Lee, D.K. Asbestos and Disease. Academic Press. 1978.
28. National Loss Control Service Corporation. Report of Industrial Hygiene Study for Ammco Tools, Inc. 1978.
29. Data from reference 3 show TWA levels with these methods at about 200,000 fibers per cubic meter. The average worker doing light to moderate work, such as a mechanic, breathes 10 cubic meters of air during an 8-hour workday, thus inhaling about 2 million asbestos fibers daily. Rohl's data (Reference 1) shows that levels 12 feet away using a dry brush were the same as using a compressed-air hose. His data also shows shop contamination of 100,000 fibers per cubic meter at distances of up to 75 feet from the site of compressed air use, and other measurements indicating significant scatter.

30. OSHA. 29 CFR 1910. 1001(h) (2).
31. EPA. Asbestos Waste Management Guidance - Generation, Transport, Disposal. EPA/530-SW-85-007. May 1985.
32. Nilfisk. Nilfisk Asbesto-Clene Systems; Rohl, A. Letter to Robert Magdelain, April 11, 1979, on air sampling during equipment use with transmission electron microscopic analysis reporting virtual elimination of asbestos levels; Nilfisk instructions for use; Nilfisk Simplifies the Safe Collection and Disposal of Toxic, Hazardous, and Nuisance Waste Materials. Nilfisk of America, Inc., 300 Technology Drive, Malvern, Pennsylvania 19355 (215) 647-6420.
33. Clayton Associates. Asbestos in Automotive Shops; Rohl, A. Letter to Jim Clayton, October 12, 1984, on air sampling during equipment use and filter change using transmission electron microscopic analysis reporting virtual elimination of asbestos levels; Asbestos and You. Clayton Associates, Inc., P.O. Box 589, 30 Southard Ave., Farmingdale, New Jersey 07727 (201) 938-6700.
34. Control Resource Systems. CRSI 2000 and CRSI Labmaster Vacuums, Brakemaster enclosure system description. Control Resource Systems, Inc., 670 Mariner Drive, Michigan City, Indiana 46360. (219) 872-5591.
35. Hako Minuteman. Hako Minuteman Asbestos Brake Drum Vacuum System. Hako Minuteman, Inc., 111 South Route 53, Addison, Illinois 60101 (312) 627-6900.
36. American Conference of Government Industrial Hygienists. Industrial Ventilation: A Manual of Recommended Practice. 18th Edition. ACGIH. Page 5-128. 1984.
37. NIOSH. Guide to Respiratory Protection for the Asbestos Abatement Industry. EPA/560-OPTS-86-001. April 1986. This contains NIOSH's most extensive recommendations for a program of respiratory protection against asbestos.

ADDITIONAL INFORMATION

This guidance was prepared to support technical materials being developed as part of the Brake Mechanic Education Program under EPA's Asbestos Action Program. The following are additional sources of information on asbestos:

EPA Regional Asbestos Coordinators:

(CT, MA, ME, NH, RI, VT)
EPA Region I
JFK Federal Building
Boston, Mass. 02203
(617) 223-0585

(NJ, NY, PR, VI)
EPA Region II
Woodbridge Avenue
Edison, N.J. 08837
(201) 321-6668

(DE, MD, PA, VA, WV)
EPA Region III
Curtis Building
6th and Walnut Streets
Phila., Pa. 19106
(215) 597-9859

(AL, FL, GA, KY, MS,
NC, SC, TN)
EPA Region IV
345 Cortland St., N.E.
Atlanta, Ga. 30365
(404) 881-3864

(IL, IN, MI, MN, OH, WI)
EPA Region V
230 S. Dearborn St.
Chicago, Ill. 60604
(312) 886-6003

(AR, LA, NM, OK, TX)
EPA Region VI
Internfirst II Bldg.
1201 Elm Street
Dallas, Tex. 75270
(214) 767-2734

(IA, KA, MO, NE)
EPA Region VII
726 Minnesota Ave.
Kansas City, Kans. 66101
(913) 236-2835

(CO, MT, ND, SD, UT, WY)
EPA Region VIII
One Denver Place
999 18th St., Suite 1300
Denver, Colo. 80202
(303) 293-1730

(AZ, CA, HI, NV, CM,
American Samoa, Guam)
EPA Region IX
215 Fremont Street
San Francisco, Calif. 94105
(415) 974-8588

(AK, ID, OR, WA)
EPA Region X
1200 6th Avenue
Seattle, Wash. 98101
(206) 442-2870

Toll-Free Numbers:
Consumer Product Safety Commission
(800) 638-2772

For information on asbestos in consumer products or homes

NIOSH
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 533-8323

U.S. Occupational Safety and Health Administration
OSHA Office of Information and Consumer Affairs
Room N-3637
200 Constitution Avenue, N.W.
Washington, D.C. 20210
(202) 523-8151

Source: This is a reprint of the Environmental Protection Agency Office of Pesticides and Toxic Substances Asbestos Action, *Guidance for Preventing Asbestos Disease Among Auto Mechanics*, June 1986.

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 3

Hydraulic System Crossword Puzzle

Use your knowledge of the brake hydraulic system and the clues below to complete the crossword puzzle on the next page.

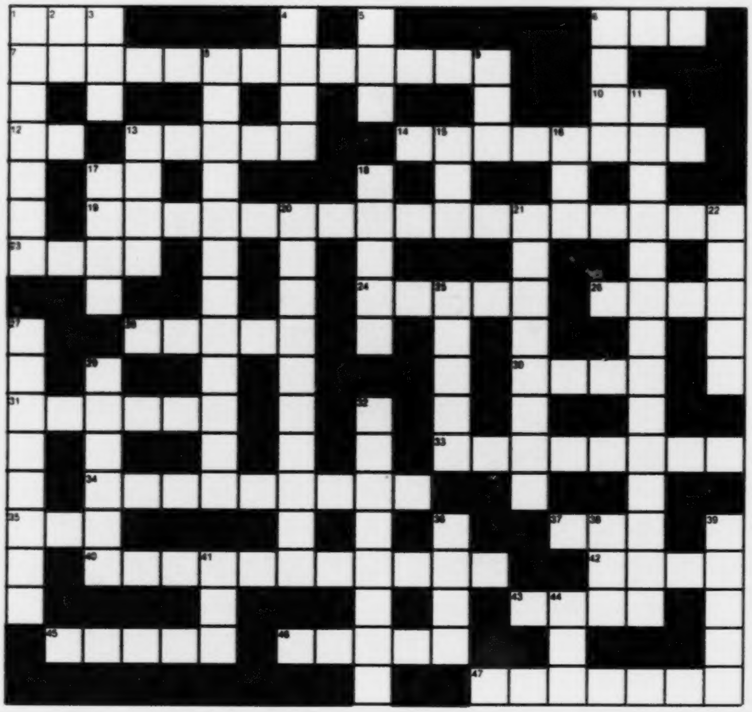
ACROSS

1. Type of brake line flare
6. Department of Transportation (abbr)
7. When maladjusted, these may cause a scraping sound (2 wds)
10. Morning (abbr)
12. Opposite of off
13. Type of bearing corrosion
14. Allowable movement at clutch pedal
17. -- no!
19. Optional power source that may be hydraulic, vacuum, or atmospheric (3 wds)
23. Day, month, and year
24. Something's worth
26. Abrasive substance
28. Type of valve that allows air or fluid to pass in one direction only
30. Unclear; foggy
31. Swapped
33. Light abrasive damage over large area
34. Fluid powered
35. National Institute of Automotive Service Excellence (abbr)
37. Brake shoe lining
40. To machine or return a part to its original diameter or state
42. Suffix for 5 Down
43. Result of rubbing, scraping, or extended use
45. Dual braking system design
46. End of vehicle commonly equipped with disc brakes
47. Part of disc brake that contains the piston(s)

DOWN

1. Shoe on vehicle frame side of brake disc
2. -- there!
3. Ingredient that should never be found in brake fluid
4. The inner or outer ring of a bearing assembly
5. Source of pneumatic power
6. Most common type of master cylinder found on today's vehicles
8. Appliance used to remove air from hydraulic system
9. Look
11. That part of hydraulic system that converts force of driver to hydraulic pressure
13. Metal plate that supports brake lining
15. Regret
16. Abbreviation for power takeoff device used on heavy equipment
17. Chooses
18. 28 Across is one of these
20. Non-petroleum-based liquid used in hydraulic system (2 wds)
21. To disassemble, recondition, and replace worn or defective parts
22. Disc in disc brake
25. What may be found on visual inspection of brake lines
27. Shoe on wheel cover side of brake disc
29. When replacing brake hoses, always use a new copper ----- at fitting
32. Resistance to motion between two objects in contact with each other
36. An opening in cylinder for passage of fluid
38. Automobile association that provides emergency road services
39. Engine
41. -- of round
44. Long, thin fish

Hydraulic System Crossword Puzzle



Solution to Hydraulic System Crossword Puzzle

I	S	O					R		A						D	O	T	
N	O	I	S	Y	B	E	A	R	I	N	G	S			U			
B		L			R		C		R			E			A	M		
O	N		S	C	A	L	E			F	R	E	E	P	L	A	Y	
A		O	H		K				V		U			T		S		
R		P	O	W	E	R	B	R	A	K	E	B	O	O	S	T	E	R
D	A	T	E		B		R		L				V			E		O
		S			L		A		V	A	L	U	E		G	R	I	T
O			C	H	E	C	K		E		E		R			C		O
U		W			E		E				A		H	A	Z	Y		R
T	R	A	D	E	D		F		F		K		A			L		
B		S			E		L		R		S	C	U	F	F	I	N	G
O		H	Y	D	R	A	U	L	I	C			L			N		
A	S	E					I		C		P			P	A	D		M
R		R	E	C	O	N	D	I	T	I	O	N			A	E	R	O
D					U				I		R		W	E	A	R		T
	S	P	L	I	T		F	R	O	N	T			E				O
									N			C	A	L	I	P	E	R

INSTRUCTOR'S SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 4

Brake System Inspection Report Form

Customer name ______________________________

Address ______________ Telephone number: Work ______________ Home ______________

Vehicle make ______________ Year ______________ Mileage ______________

License number ______________________________

Approximate time required for service ______________________________

Inspected by ______________________________ Date ______________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate**	
		Parts	**Labor**
Disc pads	☐Semi-metallic ☐Conventional		
Disc caliper	☐Recondition ☐Replace		
Disc hardware	☐Replace		
Disc rotor	☐Recondition ☐Replace		
Grease seals	☐Replace		
Front wheel bearings	☐Repack ☐Replace		
Wheel cylinders	☐Recondition ☐Replace		
Rear brake hardware	☐Replace		
Brake shoes	☐Replace		
Brake drums	☐Recondition ☐Replace		
Parking brakes	☐Adjust ☐Lubricate ☐Replace		
Power brake booster	☐Service ☐Replace		
Master cylinder	☐Recondition ☐Replace		
Brake fluid	☐Drain old, and add new fluid		
Lines, hoses, combination valve	☐Replace		
Stop light, warning light	☐Replace bulb ☐Replace switch ☐Adjust ☐Replace		
Other ______________			
	Total		

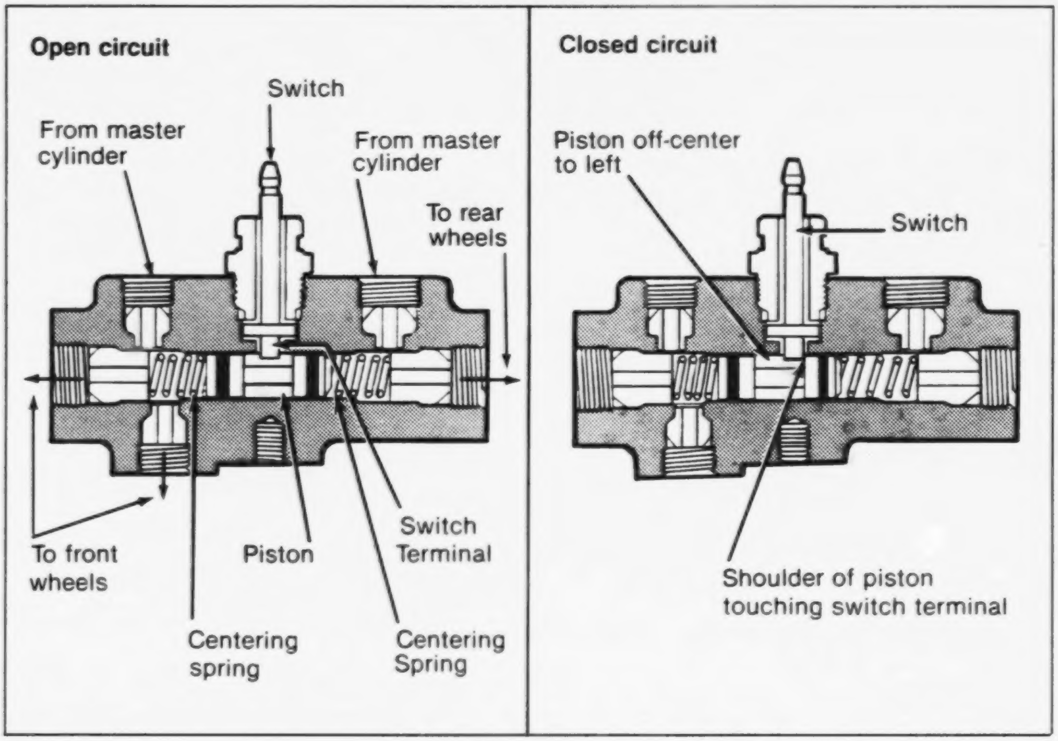
INSTRUCTOR'S SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 5

Warning Light Switch Operation

- Switch with centering springs


Open circuit
Switch
From master cylinder
From master cylinder
To rear wheels
To front wheels
Piston
Switch Terminal
Centering spring
Centering Spring
Closed circuit
Piston off-center to left
Switch
Shoulder of piston touching switch terminal

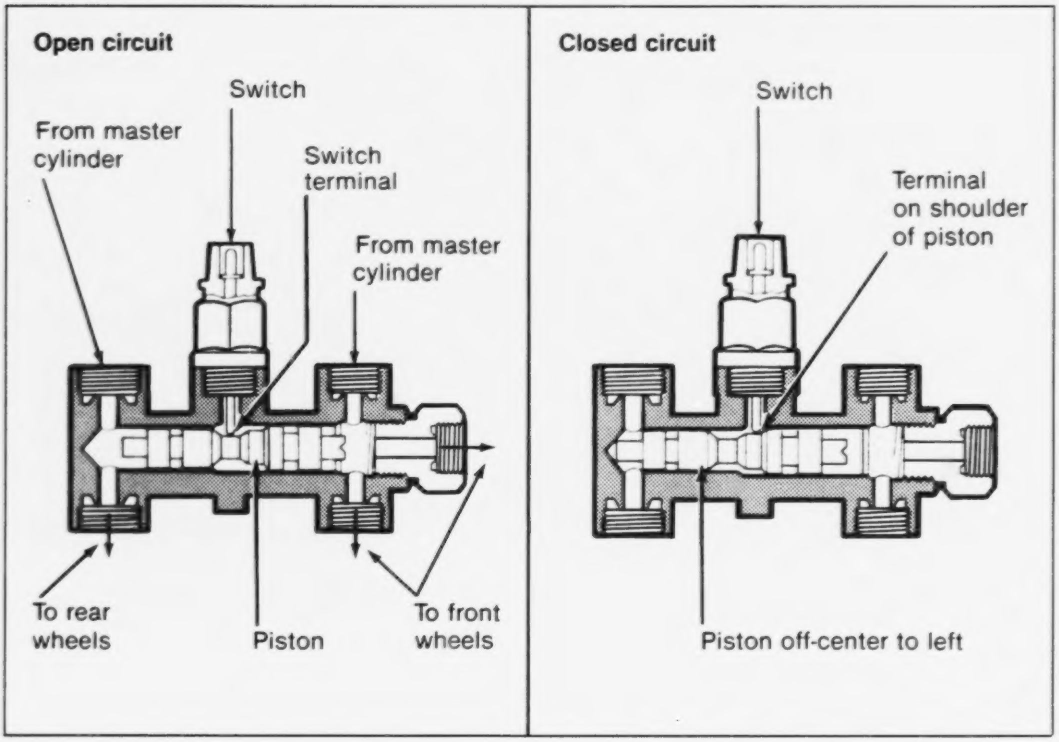
Used with permission of Allied Aftermarket.

Open circuit (warning light off) — Springs hold piston in centered position where it cannot touch switch terminal that projects into valve bore

Closed circuit (warning light on) — Higher hydraulic pressure in operative side moves piston toward inoperative side of switch where piston shoulder touches switch terminal, closing the circuit and causing brake warning light to come on

NOTE: When brakes are released and hydraulic pressure is again equal on each end of piston, the springs recenter the piston, breaking the electrical contact, and the warning light goes out.

- Switch without centering springs


Open circuit
Switch
From master cylinder
Switch terminal
From master cylinder
To rear wheels
Piston
To front wheels
Closed circuit
Switch
Terminal on shoulder of piston
Piston off-center to left

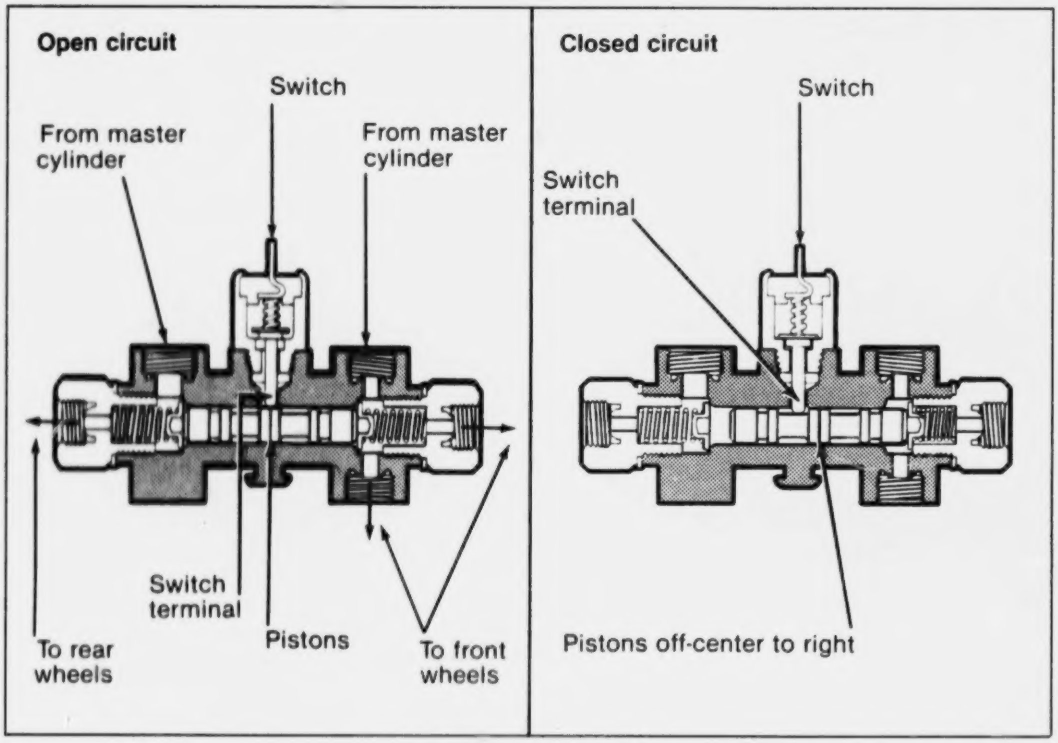
Used with permission of Allied Aftermarket.

Open circuit (warning light off) — Equal hydraulic pressure on each end of piston holds it in centered position where it cannot touch switch terminal that projects into valve bore

Closed circuit (warning light on) — Higher hydraulic pressure in operative side moves piston toward inoperative side of switch where piston shoulder pushes switch terminal upward, closing circuit and causing brake warning light to come on

NOTE: With this type of switch, the warning light will remain on until the system is bled and the piston is again centered by equal hydraulic pressure in the bore of the switch.

- Switch with centering spring and two pistons


Open circuit
Switch
From master cylinder
From master cylinder
Switch terminal
Pistons
To rear wheels
To front wheels
Closed circuit
Switch
Switch terminal
Pistons off-center to right

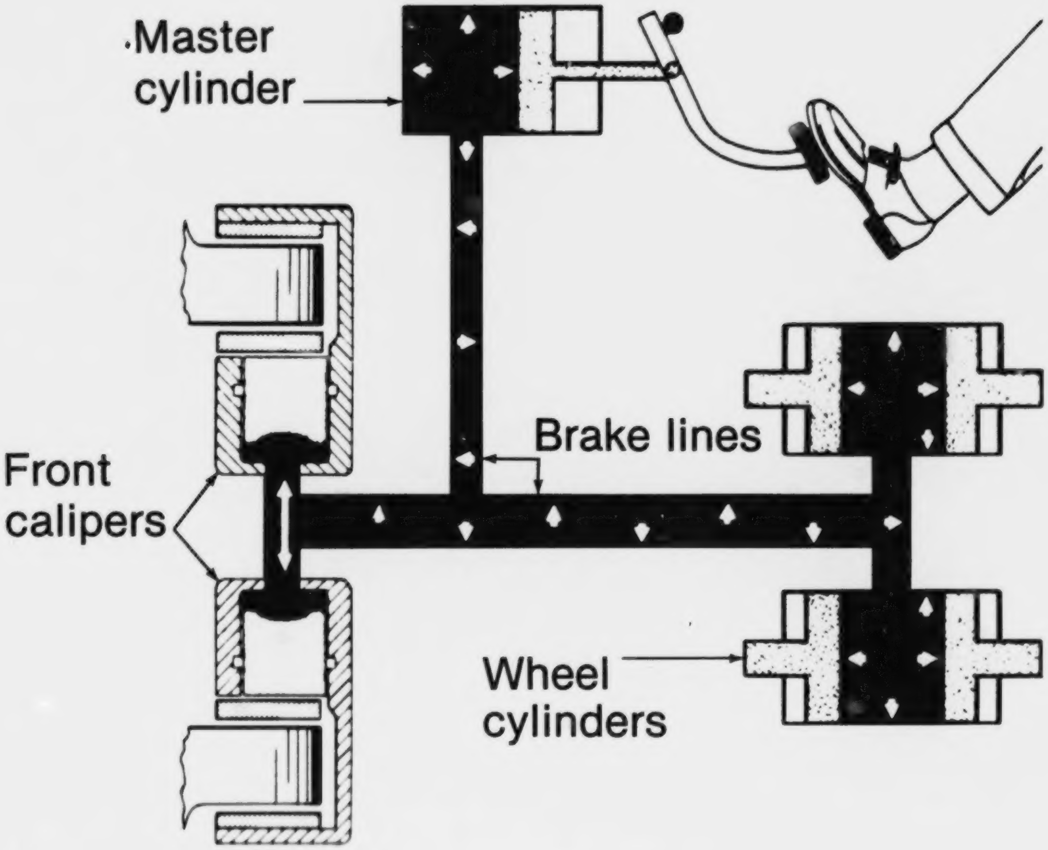
Used with permission of Allied Aftermarket.

Open circuit (warning light off) — Piston shoulders hold switch terminal in UP position, keeping circuit open

Closed circuit (warning light on) — Higher pressure in operative side moves both pistons toward inoperative side of switch, allowing switch terminal to drop downward and close the circuit, causing the brake warning light to come on

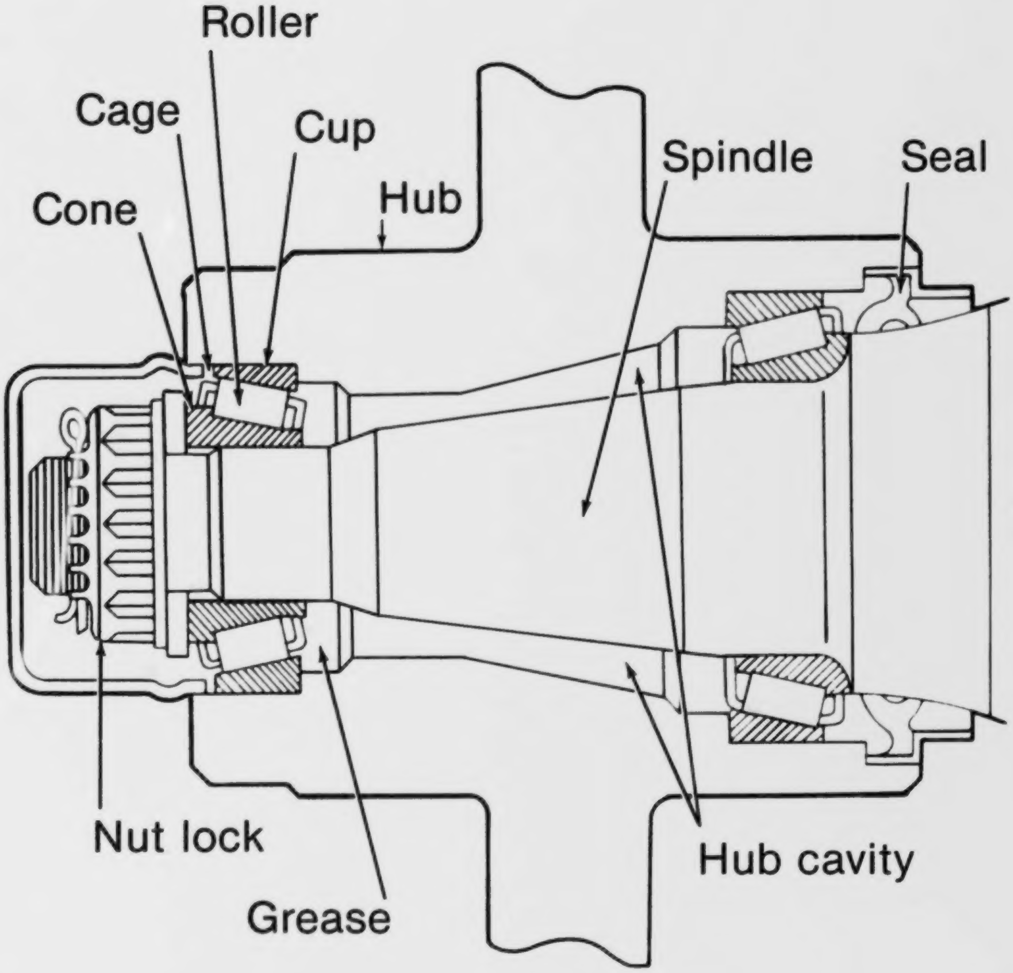
NOTE: With this type of switch, the pistons will remain off center and the warning light will remain on until the switch terminal is removed from the switch body. This must be done **before** bleeding the hydraulic system on vehicles equipped with this type of switch; otherwise the switch terminal will be damaged.

Hydraulic Brake System Operation


Master cylinder
Front calipers
Brake lines
Wheel cylinders

From *Auto Mechanics: Theory and Service*, copyright 1986. Used with permission of General Motors Corporation, Chevrolet Motor Division.

Tapered Roller Wheel Bearing

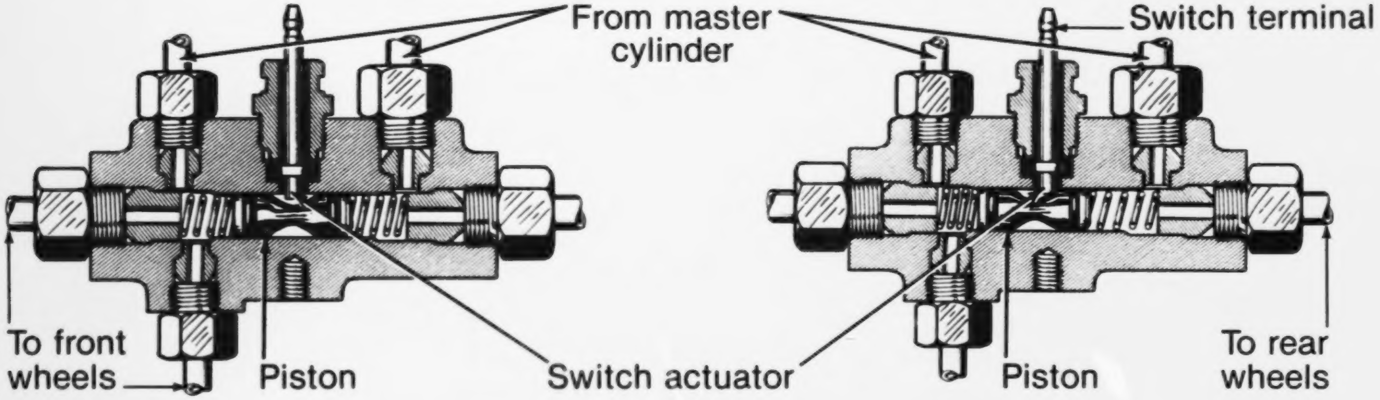

Roller
Cage
Cup
Cone
Hub
Spindle
Seal
Nut lock
Grease
Hub cavity

Used with permission of Chrysler Corporation.

Operation of Pressure Differential Valve

Valve in normal position

Valve in failed position


From master cylinder
Switch terminal
To front wheels
Piston
Switch actuator
Piston
To rear wheels

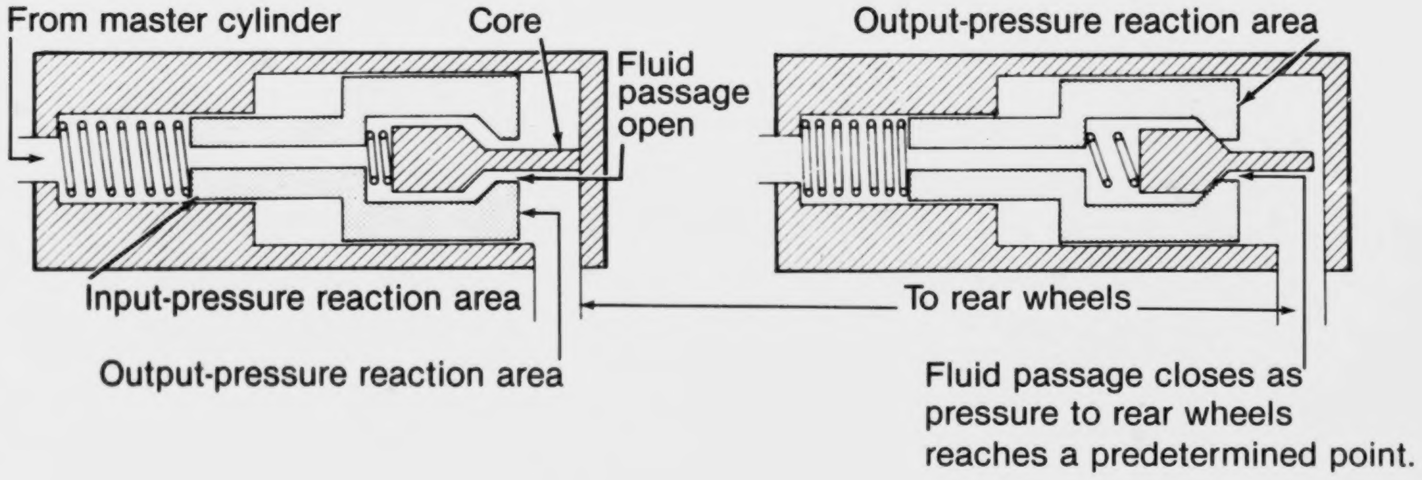
Equal pressure in both front and rear hydraulic systems

Pressure in the front hydraulic system is low, allowing the higher pressure in the rear system to move the switch piston to turn on the brake warning light.

Operation of Proportioning Valve

Released position

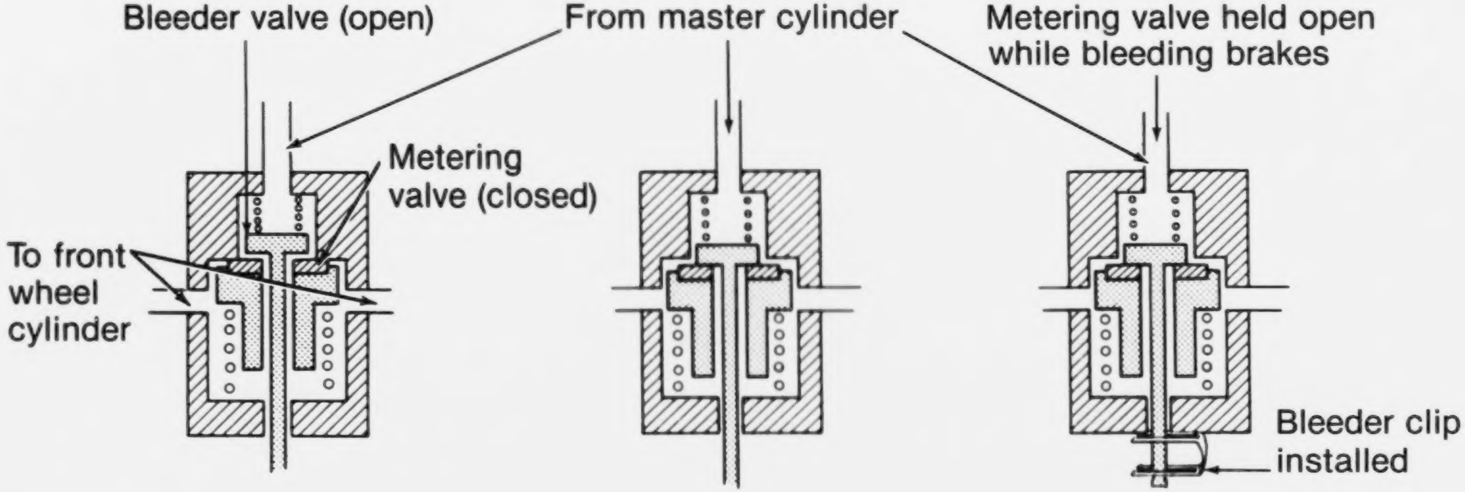
High-pressure position


From master cylinder
Core
Fluid passage open
Input-pressure reaction area
Output-pressure reaction area
Output-pressure reaction area
To rear wheels
Fluid passage closes as pressure to rear wheels reaches a predetermined point.

Proportioning valve is controlling hydraulic pressure to rear wheels to prevent tire skid as weight of vehicle shifts from rear to front wheels on hard stops.

Operation of Metering Valve

Released position **Applied position** **Bleeder position**

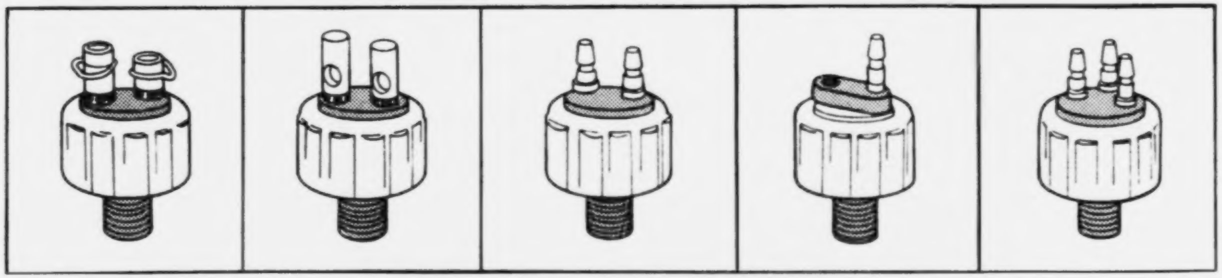

Bleeder valve (open)
From master cylinder
Metering valve held open while bleeding brakes
Metering valve (closed)
To front wheel cylinder
Bleeder clip installed

Bleeder valve remains open under 4 psi to allow fluid to expand and contract.

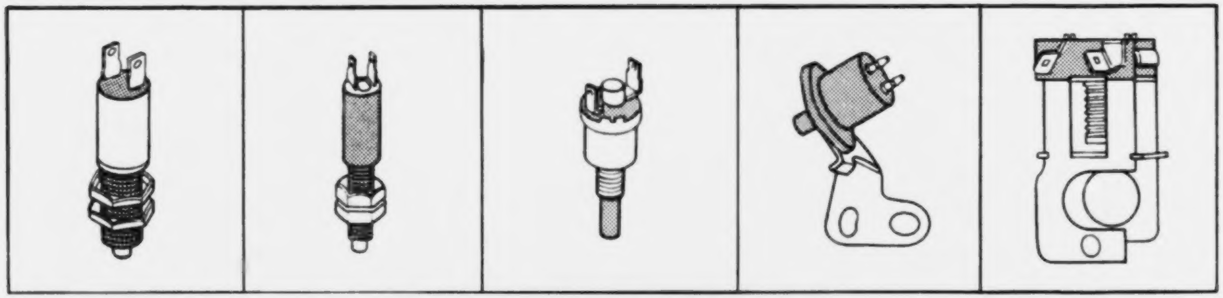
Pressure above approximately 150 psi opens the metering valve to allow pressure to front brakes.

Metering valves that have a rubber cover over the bleeder valve will require the valve to be pushed in for bleeding.

Stop Light Switch Designs



Hydraulically operated



Mechanically operated

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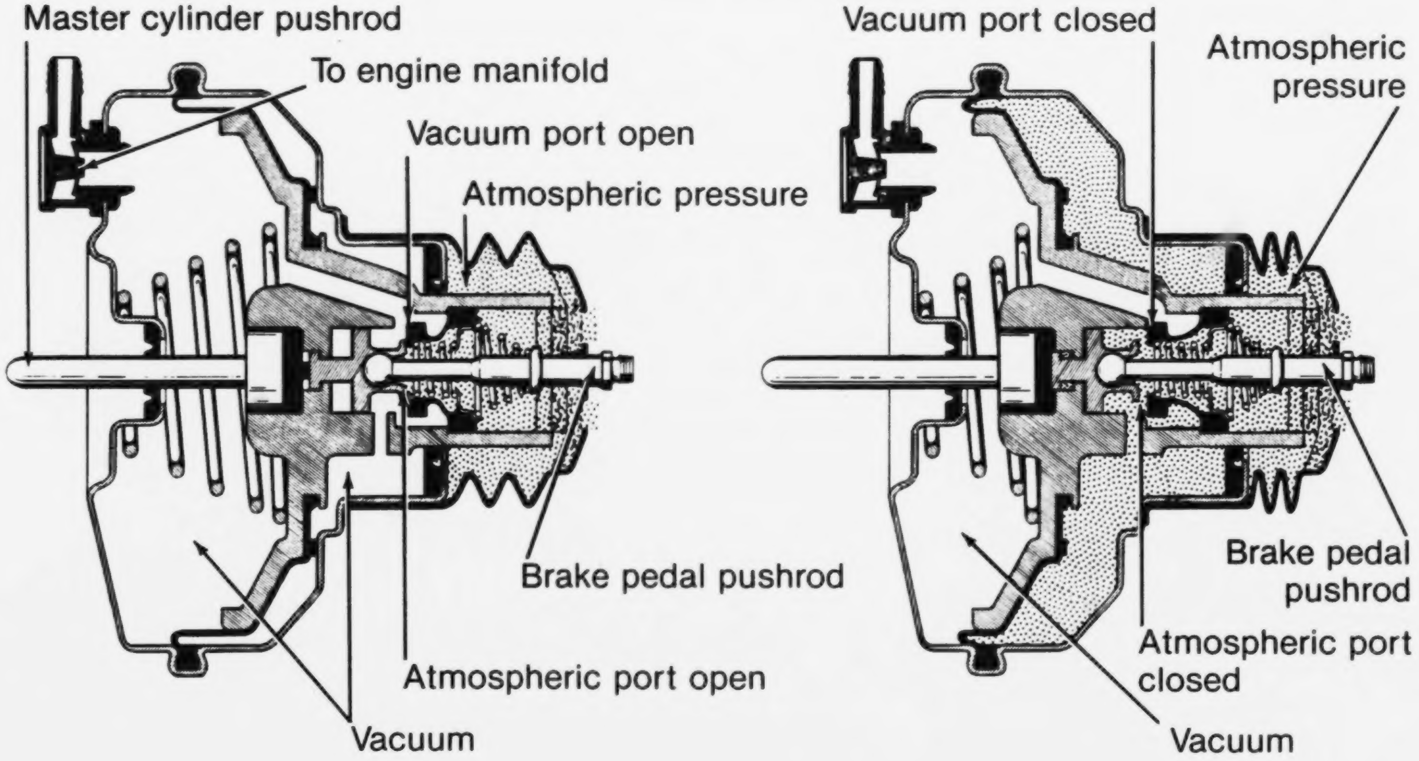
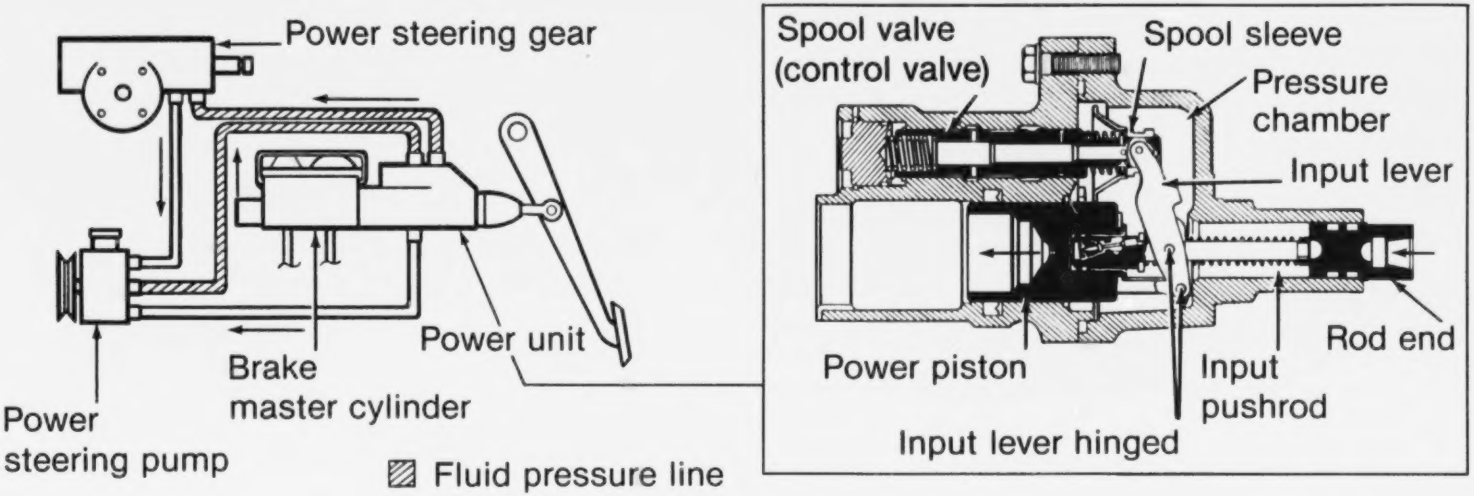
Operation of Vacuum-Suspended Power-Assist Unit

Booster in the released position **Booster in the applying position**



Master cylinder pushrod
To engine manifold
Vacuum port open
Atmospheric pressure
Brake pedal pushrod
Atmospheric port open
Vacuum
Vacuum port closed
Atmospheric pressure
Brake pedal pushrod
Atmospheric port closed
Vacuum

Operation of Hydraulic Power-Assist Unit (Mechanical Pump)

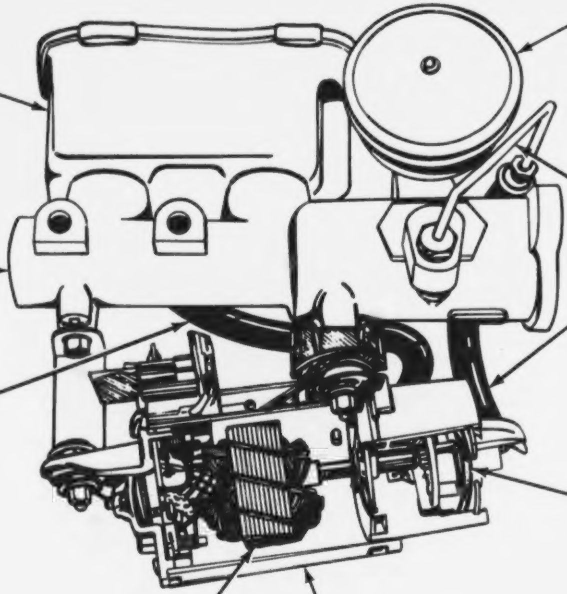

Power steering gear
Power steering pump
Brake master cylinder
Power unit
Spool valve (control valve)
Spool sleeve
Pressure chamber
Input lever
Rod end
Input pushrod
Power piston
Input lever hinged

▨ Fluid pressure line
☐ Fluid return line

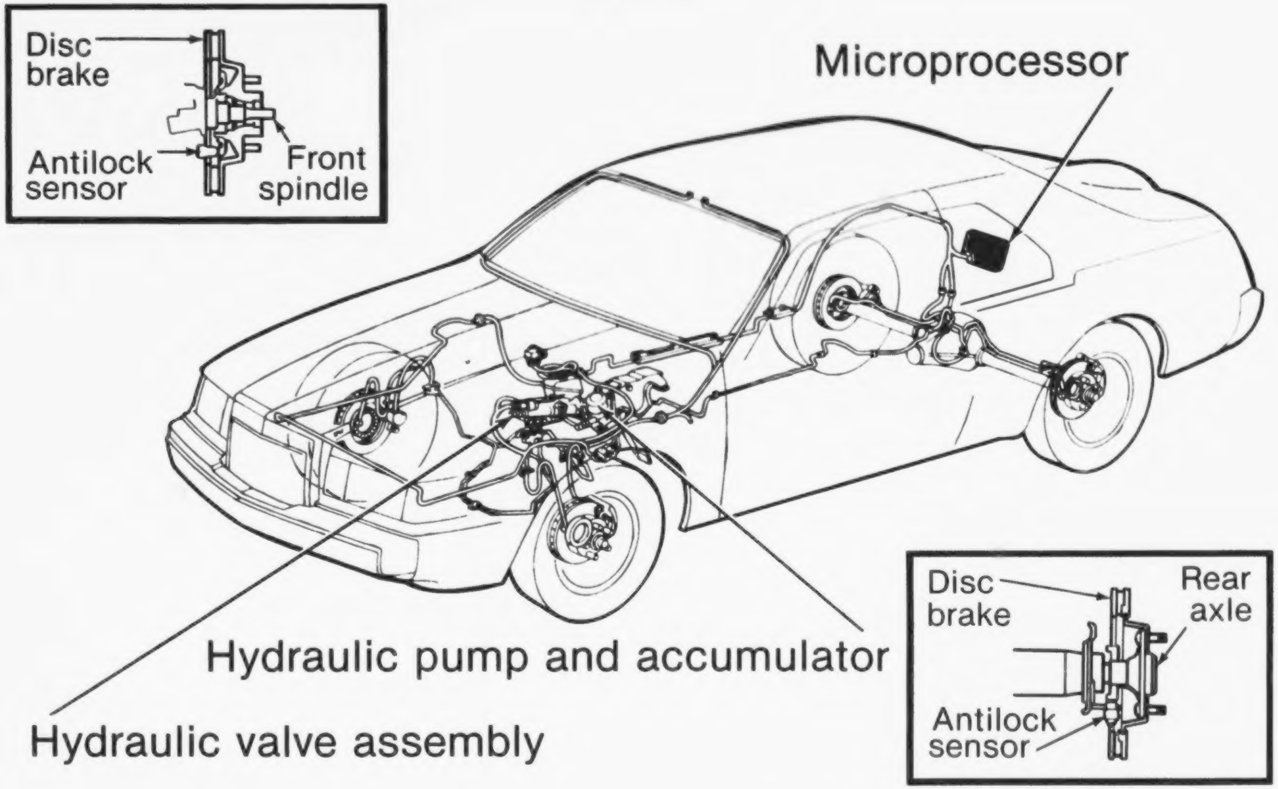
1. Pedal pushes on rod end.
2. Spool valve (control valve) allows hydraulic fluid from power steering pump to enter pressure chamber.
3. Hydraulic fluid under pressure actuates power piston.
4. Power piston acts on master cylinder to provide power assist.

From *Modern Automotive Mechanics*, copyright 1985. Used with permission of Ford Motor Company.

Operation of Hydraulic Power-Assist Unit (Electrical Pump)


Master cylinder reservoir
Accumulator
Master cylinder body
Supply hose
Return hose
Pump
Electric motor
Pump and motor housing

Typical Antiskid System Components


Disc brake
Antilock sensor
Front spindle
Microprocessor
Hydraulic pump and accumulator
Hydraulic valve assembly
Disc brake
Rear axle
Antilock sensor

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PRETEST ANSWERS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from the pretest results, use the following table, which shows the correlation between the objectives and written pretest questions. Then counsel student individually on pretest results and study requirements.

TABLE

Correlation between objectives and written pretest questions

Objective	Question
1	1, 2
2	3
3	4
4	5
5	6
6	7
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18	39
19	40
20	16, 36, 46
21	27, 37
22	28
23	31
24	29, 50
25	17
26	30
27	32
28	44, 47, 48, 49
29	26, 45
30	18
31	19
32	20

TABLE (Continued)

Objective	Question
33	21
34	23, 24, 45
35	33
36	35
37	41
38	42
39	22
40	43

ANSWER KEY

1.	c
2.	b
3.	c
4.	d
5.	b
6.	b
7.	a
8.	c
9.	a
10.	b
11.	a
12.	b
13.	d
14.	a
15.	d
16.	d
17.	b
18.	a
19.	d
20.	d
21.	c
22.	c
23.	c
24.	b
25.	a
26.	a
27.	d
28.	c
29.	a
30.	d
31.	a
32.	d
33.	a
34.	c
35.	d
36.	a
37.	d
38.	a
39.	b
40.	b
41.	b
42.	c
43.	b
44.	c
45.	b
46.	d
47.	d
48.	a
49.	c
50.	b

PRETEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

Name ____________________ Score __________

DIRECTIONS

Read the following questions and problems. Then circle the letter before the item that best answers the question or solves the problem.

1. Which of the following is the best definition of *hydraulic power-assist unit*?

   a. Device that uses hydraulic pressure supplied by intake manifold to assist in applying brakes
   b. Device that uses hydraulic pressure supplied by wheel cylinder to assist in applying brakes
   c. Device that uses hydraulic pressure supplied by power steering pump or electrically driven pump to assist in applying brakes
   d. Device that uses hydraulic pressure supplied by armature to assist in applying brakes

2. Which of the following best defines *asbestosis*?

   a. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos
   b. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
   c. Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos
   d. Bronchial irritation that causes coughing and hoarseness; caused by exposure to asbestos

3. Which of the following is **not** a basic component of a brake hydraulic system?

   a. Brake lines and hoses
   b. Master cylinder
   c. Accumulator
   d. Combination valve

4. In hydraulic brake operation, the brake combination valve is used to

   a. Apply specified pressure to parking brakes
   b. Increase force into master cylinder
   c. Prevent backflow of fluid
   d. Delay front brake operation

5. Which of the following is a characteristic of good brake fluid?

   a. Should be able to repel moisture that collects in system
   b. Should have a low freezing point
   c. Should be interchangeable with power steering fluid
   d. Should have a low boiling point

6. Change brake fluid ______, taking care not to spill fluid on any chrome or painted surface, as it will damage these finishes

   a. Once a month
   b. At each major brake repair
   c. At 15,000-mile checkup
   d. At least once a year

7. An ISO flare fitting for steel brake lines differs from a conventional double flare fitting in that

   a. It requires no tube seats and cannot be overtightened
   b. It has a flexible male fitting
   c. It is secured with a line or tube nut
   d. It is designed to grip both the inside and outside of line

8. A lever-type tubing bender rolls tubing around a wheel shaped like a pulley and may be used on

   a. ISO flared tubing only
   b. Unflared tubing only
   c. Flared or unflared tubing
   d. Copper tubing only

9. Which of the following is a dual braking system design?

   a. Diagonally split
   b. Horizontally split
   c. Parallel
   d. Side-to-side

10. Which of the following practices violates asbestos safety rules?

    a. Using preground, installation-ready brake linings when possible
    b. Washing hands and face after eating and laundering clothes at home
    c. Not eating, drinking, or smoking in any area where brake work is done
    d. Using the most up-to-date enclosure-type brake cleaner equipped with a HEPA-type vacuum cleaner filter

11. Which of the following is the best definition of *press fit*?

    a. Installation of a bearing cup with a tight or interference fit requiring more than hand pressure to install
    b. To adjust bearings so that they will work under mild pressure
    c. Installation that allows axial movement in hub because of proper bearing clearance
    d. Installation of a bearing cone assembly with a light fit that can be installed with hand pressure

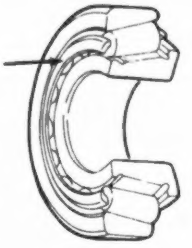
12. The most common wheel bearing design used in today's automobiles is the

    a. Straight roller
    b. Tapered roller
    c. Ball
    d. Integrated (sealed) ball

13. Which of the following is the main purpose of wheel bearings?

    a. To transfer undesirable road shock from brakes to tires
    b. To transfer steering action to the vehicle wheels
    c. To allow driver to sense turning resistance
    d. To reduce friction between revolving wheel hub and spindle

14. Refer to the illustration of the roller wheel bearing assembly below. To which component is the arrow pointing?

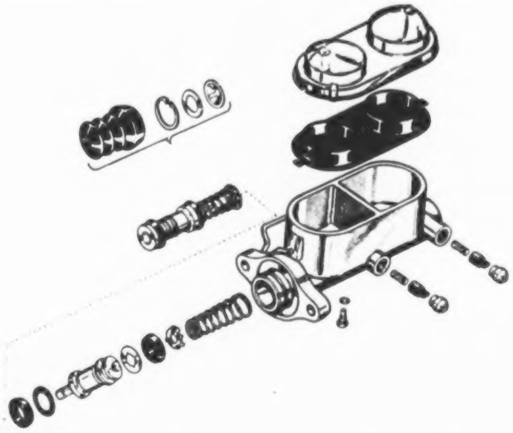


a. Cage
b. Roller
c. Outer race
d. Cone assembly

15. Which of the following is **not** a property of wheel bearing grease?

a. Is water-resistant
b. Is heat-resistant
c. Is noncorrosive
d. Is easily separated at high temperatures

16. Refer to the illustration of the typical dual master cylinder below. Which part is **not** in the correct position?



Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

a. Residual check-valve spring
b. Diaphragm
c. Primary piston
d. Secondary piston

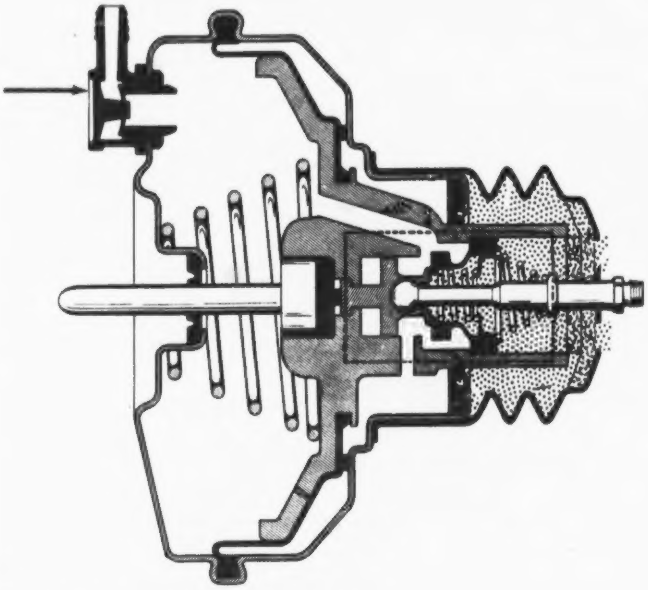
17. A combination valve consists of a

    a. Metering valve, power booster valve, and proportioning valve
    b. Metering valve, pressure differential valve, and proportioning valve
    c. Heat-sensing valve, pressure differential valve, and power booster valve
    d. Heat-metering valve, pressure booster valve, and residual check valve

18. Which of the following types of power-assist units is most commonly found on today's vehicles?

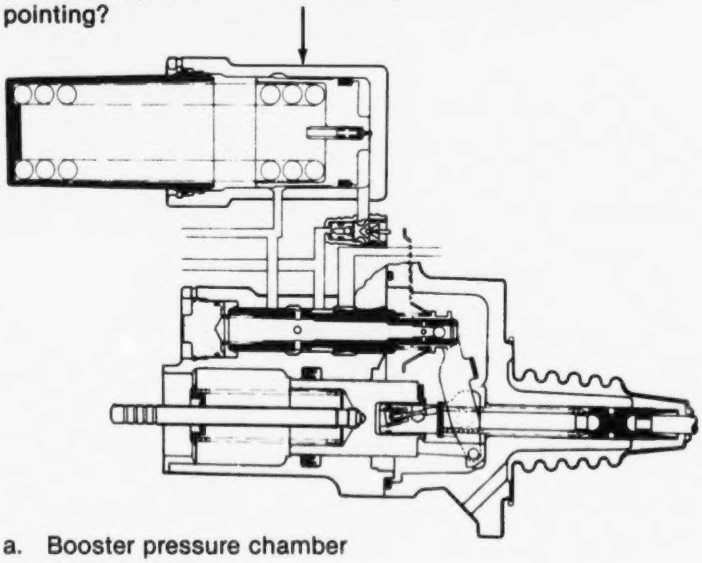
    a. Vacuum-suspended
    b. Atmosphere-suspended
    c. Mechanically driven hydraulic
    d. Electrically driven hydraulic

19. Refer to the illustration of the vacuum power-assist unit below. To which component is the arrow pointing?



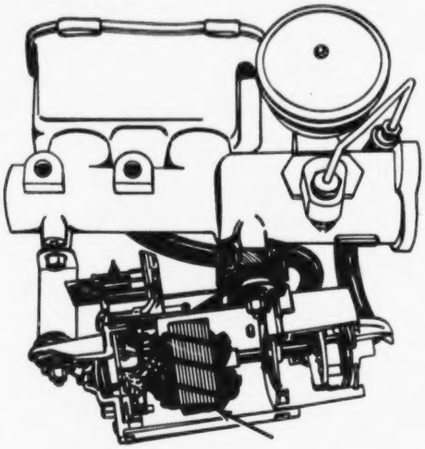
    a. Power piston return spring
    b. Floating control valve
    c. Master cylinder pushrod
    d. Vacuum check valve

20. Refer to the illustration of the hydraulic power-assist unit (mechanical) below. To which component is the arrow pointing?



a. Booster pressure chamber
b. Pump reservoir
c. Output chamber
d. Accumulator

21. Refer to the illustration of the hydraulic power-assist unit (electrical pump) below. To which component is the arrow pointing?



a. Check valve
b. Pressure regulator
c. Electric motor
d. Booster body

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22. Which of the following is the function of the solenoid valve in a brake antiskid system?

a. Transmitting lock-up condition to controller
b. Monitoring for lock-up condition
c. Controlling pressure in lock-up situation
d. Activating light on dash when there is a malfunction in system

23. While servicing a vehicle equipped with vacuum power brakes, the brakes specialist discovers leakage at the reaction diaphragm. Which of the following conditions would be caused by this defect?

a. Pedal fails or is slow to release
b. Hard pedal
c. Sensitive brakes
d. Pedal goes to floor

24. The spool return spring is damaged on a vehicle equipped with a hydraulic power-assist unit. Which of the following conditions would such damage cause?

a. Excessive brake pedal effort
b. Slow brake pedal return
c. System does not hold charge
d. Brake pedal vibration

25. When servicing brake lines and hoses, the brakes specialist should always use

a. New copper washers
b. New copper tubing
c. ISO flared fittings
d. Single-flared fittings

26. Of the following bearing problems, which does not require replacing the bearings?

a. Stain discoloration
b. Etching
c. Misalignment
d. Galling

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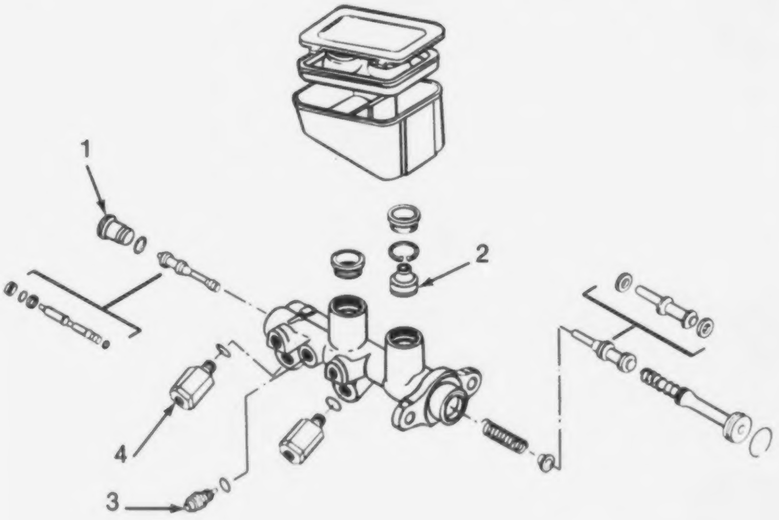
27. If external leakage is found at the rear of the master cylinder

    a. The secondary piston seal is leaking and must be replaced
    b. The reservoir diaphragm is loose and must be secured by bending the cover bails to apply more tension
    c. The primary piston seal is leaking and the master cylinder must be replaced
    d. The primary piston seal is leaking and must be replaced

28. Which of the numbered components on the quick take-up master cylinder illustrated below is the take-up valve assembly?



Used with permission of Allied Aftermarket.

    a. 1
    b. 2
    c. 3
    d. 4

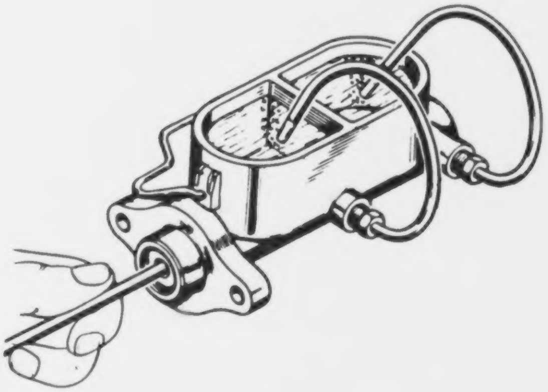
29. If a master cylinder bore is scored or pitted,

    a. It may be honed if the diameter is not increased by more than .002 inch
    b. It must be replaced
    c. It must be threaded with a self-tapping screw
    d. It may be reconditioned if the diameter is not increased by more than .005 inch

30. Always use a ______ when removing lines from a combination valve.

   a. Pair of vise-grip pliers
   b. Screwdriver
   c. Open-end wrench
   d. Tubing wrench

31. What is the brakes specialist doing in the illustration below?



From *Brakes*, 2nd ed., copyright 1978. Used with permission of Chrysler Corporation.

   a. Bench bleeding a master cylinder
   b. Surge bleeding a master cylinder
   c. Flushing a master cylinder
   d. Checking master cylinder piston end play

32. The purpose of a load-sensing proportioning valve is to

   a. Redistribute cargo load
   b. Control amount of front braking force
   c. Transfer load to front wheels
   d. Reduce chance of rear wheel lockup

33. When testing vacuum booster engine supply with a vacuum gauge, the gauge should be attached to the

   a. Intake manifold vacuum connection
   b. Power steering pump vacuum connection
   c. Master cylinder vacuum connection
   d. Accumulator vacuum connection

34. When bleeding the brakes, the specialist normally starts with the caliper or wheel cylinder

a. Closest to master cylinder
b. On same side as master cylinder
c. Farthest from master cylinder
d. On right front side

35. A problem in a hydraulic power-assist unit (mechanical) may affect the

a. Parking brake system
b. Suspension system
c. Electrical system
d. Steering system

36. Tube seats are normally used in

a. Outlet ports
b. Filler ports
c. Bleeder ports
d. Compensating ports

37. Before reassembling a master cylinder, you should

a. Inspect all rubber parts and reuse only those in good condition
b. Use only reconditioned master cylinder made of aluminum
c. Bleed the brake system
d. Dip each component in brake fluid

38. Bearing assemblies and grease seals are normally removed from the rotor or drum with

a. A hammer and wooden dowel
b. Compressed-air pressure
c. A bearing packer
d. Diagonal pliers

39. Wheel bearings are adjusted by

a. Measuring hub assembly looseness with a micrometer
b. Torquing the spindle nut to manufacturer's specifications
c. Torquing nut lock to manufacturer's specifications
d. Removing and repacking bearings

40. Which of the following statements is false concerning integral wheel bearings (sealed bearings)?

a. Integral wheel bearings are lubricated for life
b. Integral wheel bearings are adjustable
c. Integral wheel bearings are not adjustable
d. Failure of integral wheel bearings calls for unit replacement

41. Before replacing a hydraulic power-assist unit with mechanical pump, you must deplete the accumulator of all reserve fluid stored under pressure. Which of the following is the correct method for accomplishing this?

a. Remove excess fluid with syringe
b. Pump brake pedal several times with ignition off
c. Remove accumulator outlet plug and drain fluid into a suitable container
d. With engine on, turn steering wheel to right and left several times

42. Brakes specialist A says that the bores of a hydraulic power-assist unit (electrical pump) must not be honed and that if they are pitted or scored the entire power booster assembly must be replaced.

Brakes specialist B says that on this type of power-assist unit, the unit must be fully depressurized before any service is performed.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

43. Brakes specialist A says that when adjusting or repairing a brake antiskid system, the specialist must always disconnect the wheel sensor before disconnecting the electronic controller.

Brakes specialist B says that no adjustment or repairs should be made to an antiskid system and that damaged or worn parts should be replaced.

Who is right?

a. Brakes specialist A
b. Brakes specialist B
c. Both A and B
d. Neither A nor B

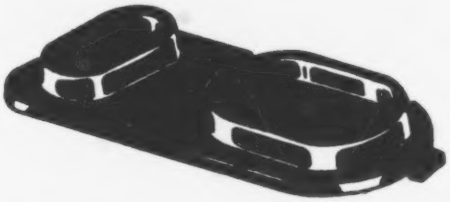
44. If stop light does not come on when the brake pedal is depressed, the stop light switch should be replaced if

a. The warning light comes on and remains on
b. The circuit closes when the brake pedal is depressed approximately 2 inches
c. The stop lights come on when a jumper wire is used to bypass switch
d. The bulbs are burned out or the sockets are defective

45. A vehicle equipped with a vacuum power-assist unit is losing an excessive amount of fluid. There is no sign of external leakage. What would be the first thing to do?

a. Remove the check valve and measure vacuum
b. Remove the check valve and look inside booster
c. Check compensating port clearance
d. Check brake pedal free travel

46. Many brake systems use a rubber diaphragm similar to the one illustrated below. What is its function?



a. To eliminate the need for a residual check valve
b. To maintain static pressure
c. To allow for brake pedal pump-up if the pedal is low
d. To prevent water and dirt contamination

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 21, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

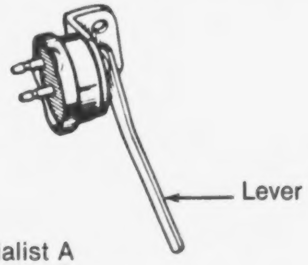
47. Which of the following can cause the brake warning light to come on?

a. Shorted light circuit
b. Worn master cylinder
c. Leak in brake line
d. All of the above

48. Brakes specialist A says that the switch below can be tested by using a jumper wire to bypass it.

Brakes specialist B says that the switch below can be tested by grounding either terminal.

Who is right?



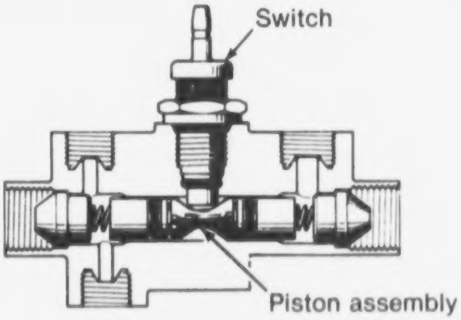
a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., © 1983, p. 26, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

49. Brakes specialist A says that the switch illustrated below completes a ground circuit.

Brakes specialist B says that the piston in the illustration will be displaced during bleeding, but will recenter itself and open the circuit after pressure is decreased below a certain point by releasing the brake pedal.

Who is right?



a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., © 1983, p. 26, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

50. When overhauling a master cylinder, the cylinder should be checked for excessive piston clearance by placing a ¼-inch-wide feeler shim lengthwise in the cylinder bore. If piston can be inserted with the shim in place,

a. The cylinder is not oversized
b. The cylinder is oversized and should be discarded
c. The cylinder is oversized, but is still usable if shim does not easily come out of the cylinder when the piston is in place
d. The piston should be replaced with a larger-diameter piston

INFORMATION SHEET

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 1

Recognize definitions of terms associated with the brake hydraulic system

Asbestosis — Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath

Bleeding — Process by which air and contaminants are removed from hydraulic system by draining part of the fluid or by operating system to work out these contaminants

Brake — Device used to slow, stop, or hold a vehicle by changing kinetic energy of motion into heat energy

Kinetic Energy

Kinetic energy is the term applied to energy in motion. When the braking system stops a vehicle, it does so by overcoming this energy in motion. The more energy that is in motion, the more power that is required to stop the vehicle. The amount of kinetic energy in a moving vehicle is the result of two things: how much the vehicle weighs and how fast the vehicle is going. If the weight or speed of a vehicle increases, the energy needed to stop the vehicle also increases. For example, it takes twice as much energy to stop a 4,000-pound car traveling at 30 mph as it does to stop a 2,000-pound car traveling at that same speed. If the speed of a vehicle is increased from 20 mph to 40 mph, the energy required to stop it quadruples—that is, increases by four times as much. Similarly, it takes eight times (2 × 4) as much energy to stop a 4,000-pound car traveling 40 mph as compared to what it takes to stop a 2,000-pound car traveling 20 mph.

Not only does it take more energy to stop heavier and faster vehicles, but it also takes more time. This is because the kinetic energy of the vehicle must go somewhere. In an automotive braking system, this energy is changed to heat and can be felt in the brakes and wheel assembly of a car that has just stopped. However, even though a car traveling at a higher rate of speed requires more energy to stop it, the rate at which the brakes can convert that kinetic energy to heat remains the same. Thus, it takes longer for the vehicle going 40 mph to stop than the one going 30 mph because it takes longer for the brakes to dissipate the additional kinetic energy.

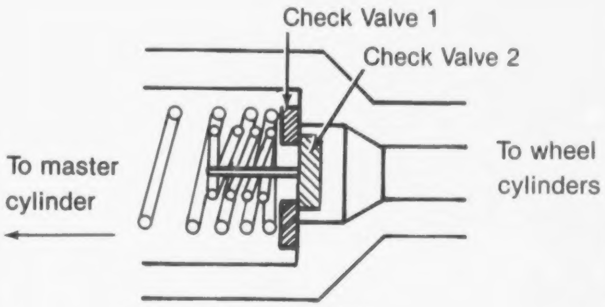
Brake fluid — Non-petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as *brake lines*

Check valve — Device that allows air or liquid to pass in one direction only

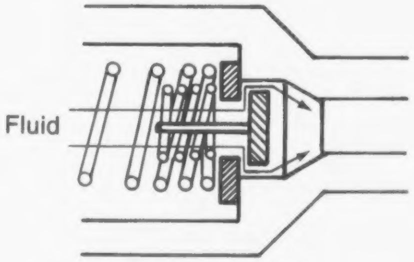
NOTE: The purpose of the fluid check valve—which is actually two separate valves in a single assembly—is to keep the hydraulic system under enough pressure to prevent air from entering it. See Figure 1 on the following page.

EXAMPLE:

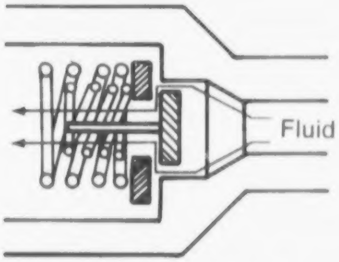
FIGURE 1



Normally both valves are closed.



With the brake pedal applied, hydraulic pressure opens check valve 2 and additional fluid flows to the wheel cylinders



When the brake pedal is released, the pressure of the wheel cylinders forces the fluid to open check valve 1 and flow back to the master cylinder

Dual master cylinder — Component of the hydraulic system that converts driver force to hydraulic pressure; contains two pistons, each piston serving two wheel brakes

NOTE: Single-piston master cylinders were installed on domestic vehicles until 1966. The main purpose of the dual master cylinder is to provide a safety backup should one system fail.

Flushing — Process of removing all old fluid from hydraulic system and replacing it with new fluid

Free play (brake) — Clearance between master cylinder actuator rod and piston assembly

Hydraulic power-assist unit — Device that uses hydraulic pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

Lung cancer — Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

NOTE: Other cancers that appear to be caused by asbestos exposure include cancer of the stomach, large intestine, and voice box. The risks of getting cancer are increased significantly for smokers exposed to asbestos.

Mesothelioma — Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos

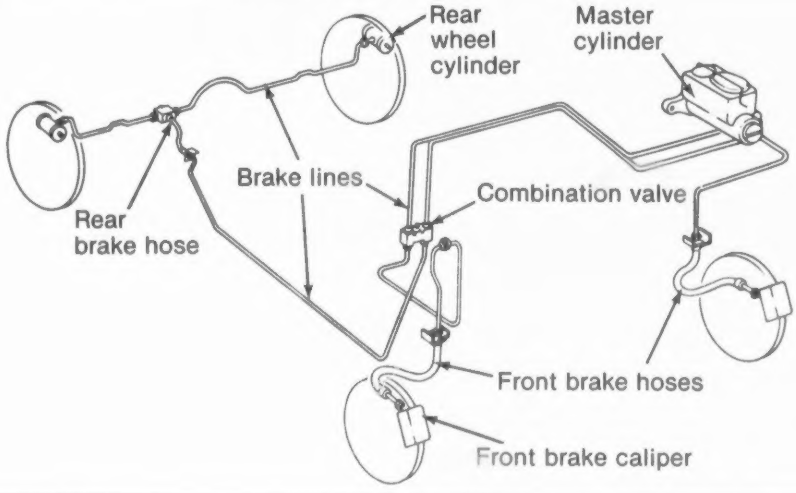
Overhaul — To disassemble, recondition worn parts, replace defective parts, and reassemble a component or assembly

Recondition — To machine or return a part to its original surface condition

Vacuum power-assist unit — Device that uses vacuum pressure supplied by intake manifold to assist in applying brakes

OBJECTIVE 2 | **Recall the basic components of a hydraulic brake system**

FIGURE 2

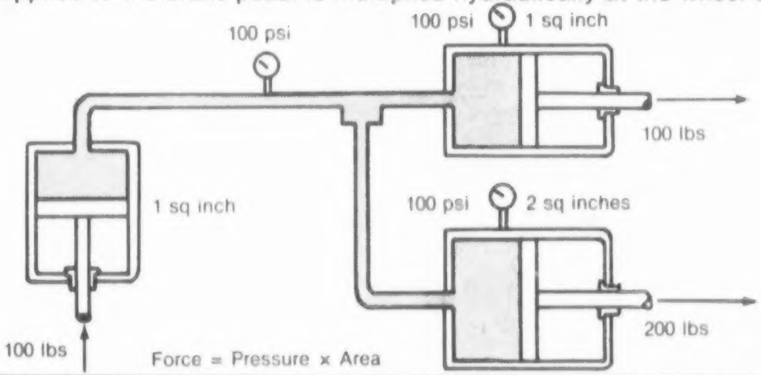

Rear wheel cylinder
Master cylinder
Brake lines
Combination valve
Rear brake hose
Front brake hoses
Front brake caliper

Courtesy Chrysler Corporation.

Overcoming Force

Tremendous forces are involved when braking a vehicle because a vehicle must be brought to a stop in a much shorter time than is required to bring it up to speed. For instance, a vehicle with a 100-horsepower engine requires about 60 seconds to accelerate to 60 miles per hour. However, the same vehicle is expected to be able to stop from 60 miles per hour in not more than 6 seconds. In other words, the brakes must do the same work as the engine, but in one-tenth the time. In this case, this means that they must develop 1000 horsepower to stop the vehicle.

Hydraulic brakes provide the force needed to brake a vehicle. The drawing below shows how force applied to the brake pedal is multiplied hydraulically at the wheel cylinders.


100 psi
100 psi
1 sq inch
100 lbs
1 sq inch
100 psi
2 sq inches
200 lbs
100 lbs
Force = Pressure × Area

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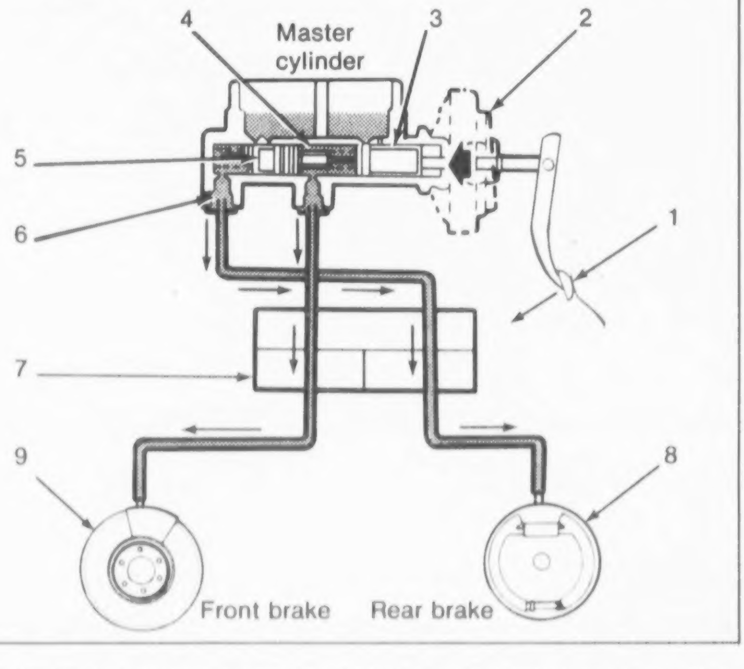
OBJECTIVE 3

Recall the steps in hydraulic brake operation

1. Brake pedal is depressed
2. Booster (if used) increases force into master cylinder
3. Pushrod forces primary piston forward
4. Fluid in primary cylinder is pressurized to apply front brakes
5. Pressure in primary cylinder pushes secondary piston forward
6. Secondary cylinder is pressurized to apply rear brakes
7. Brake combination valve is used to
    - delay (meter) front brake application
    - proportion rear pressure to front pressure on some models
    - trigger warning system
8. Pistons in wheel cylinder push brake shoes against drum in drum-type brakes used on rear wheels
9. Piston(s) in caliper forces brake pad against rotor in disc-type brakes used on front wheels

FIGURE 3



From *Mitchell Automechanics*, copyright 1986. Used with permission of Ford Motor Company.

OBJECTIVE 4

Recall characteristics of good brake fluid

Viscosity — Should be free-flowing at all temperatures

Boiling point — Should have high boiling point so that it remains in liquid state at highest operating temperatures encountered

Corrosion — Should be noncorrosive so that it does not attack rubber or metal parts, and should act as an antirust agent

Water tolerance — Should be able to absorb and retain moisture that collects in system

Lubricating ability — Should lubricate pistons and cups to reduce wear and internal friction

Freezing point — Should have low freezing point so that it remains fluid and flows at low ambient and operating temperatures

Types of Brake Fluid

Federal law requires that brake fluid meet certain standards and specifications before it is sold. The federal government has set specifications for three types of brake fluid for automotive use: DOT 3, DOT 4, and DOT 5. Each type must have a specified color. DOT 3 and DOT 4 are amber to clear in color, while DOT 5 is purple. The main differences between DOT 3 and DOT 4 are that DOT 4 has a higher wet boiling point and absorbs moisture more slowly than does DOT 3 fluid. DOT 5 fluid is silicone-based and has a higher boiling point than either of the other two types. DOT 3 and DOT 4 may be mixed with each other, but DOT 5 should **never** be mixed with either of them. Before using DOT 5 check vehicle manufacturer's specifications—some manufacturers advise against the use of DOT 5 brake fluid.

OBJECTIVE 5

Recognize guidelines for handling and storing brake fluid

- Change brake fluid at each major brake repair, taking care **not** to spill fluid on any chrome or painted surface as it will damage these finishes
- Always keep brake fluid clean; do **not** allow any foreign material or petroleum product (gasoline, kerosene, oil, grease) to get into the fluid
- **Never** use containers contaminated with grease, oil, dirt, rust, etc.
- Always clean off top of fluid reservoir before refilling it in order to avoid contamination of brake fluid
- Use smallest possible can of brake fluid to fill master cylinder; use two small cans rather than half a large can
- Tightly cap fluid container after use
- Keep master cylinder tightly covered, and reinstall cover immediately after filling master cylinder with new fluid
- Keep fluid reservoir in pressure brake bleeder tightly closed except when refilling
- Store brake fluid away from heat or flame, as it is highly flammable

More About Brake Fluids

Brake fluids (except silicone) absorb moisture when exposed to air. This greatly reduces their boiling point. High-temperature fluids (specified for heavy-duty and disc-brake use) lose their boiling points more quickly than regular fluids. Absorption of even 3 percent moisture brings down the boiling point of high-temperature fluids by about 50 percent. This can happen if a master cylinder cap is left off overnight or if a can is left partially filled for even a day or two. The effect of moisture contamination and a reduced boiling point is vapor lock, a condition that occurs when brake heat boils the fluid into vapor so that the pedal stroke is used up to compress the gas. With enough vapor accumulation, the master cylinder can run out of stroke before the brakes are applied. Often this condition disappears before being checked, since the vapor returns to fluid when it is cooled. To be safe, always replace the fluid when you suspect moisture contamination.

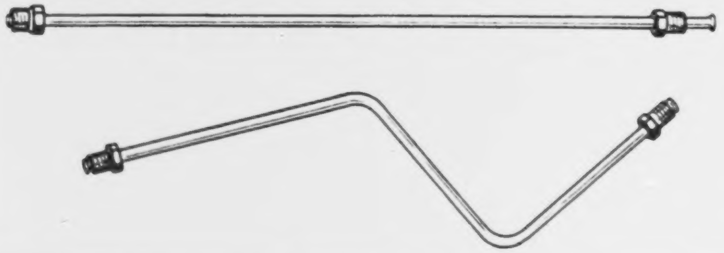
OBJECTIVE 6

Recall distinguishing characteristics of hydraulic lines and fittings

Tubing — Hollow brake line of bendable steel coated to resist rust and corrosion and double flared at both ends to accept male fittings (Figure 4)

EXAMPLE:

FIGURE 4

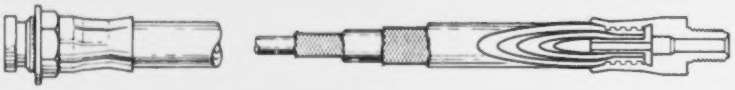


Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

Hose — Hollow brake line of alternating layers of flexible rubber and fabric with threaded metal fittings at both ends (Figure 5)

EXAMPLE:

FIGURE 5

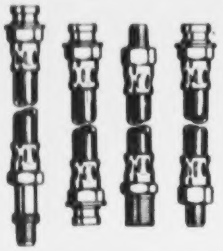


From *Brakes*, 2nd ed., copyright 1978. Used with permission of Allied Aftermarket.

Hose end fittings — Threaded metal fittings designed to grip both inside and outside of hose; generally one end accepts a male fitting and the other accepts a female fitting (Figure 6)

EXAMPLE:

FIGURE 6

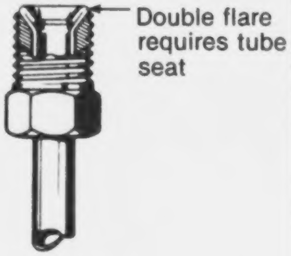


Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

Double flare fitting — Double lapped and flared steel tubing that is secured with a line or tube nut and requires a tube seat (Figure 7)

EXAMPLE:

FIGURE 7



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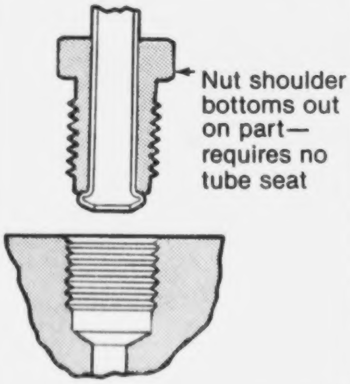
International Standards Organization (ISO) flare fitting — Flare design that requires no tube seats and cannot be overtightened because shoulder of line or tube nut bottoms out in body of part, creating uniform pressure on flare (Figure 8)

NOTE: The ISO flare is a fairly new design and is rapidly gaining acceptance. It has a number of advantages over the standard double flare: (1) Tube seats are no longer needed, (2) when tightened the shoulder of the nut bottoms out in the body of the part, creating a uniform pressure on the flare, and (3) the design is not subject to overtightening. The brakes specialist merely tightens the nut firmly on the seat, and the correct sealing pressure occurs automatically.

EXAMPLE:

FIGURE 8



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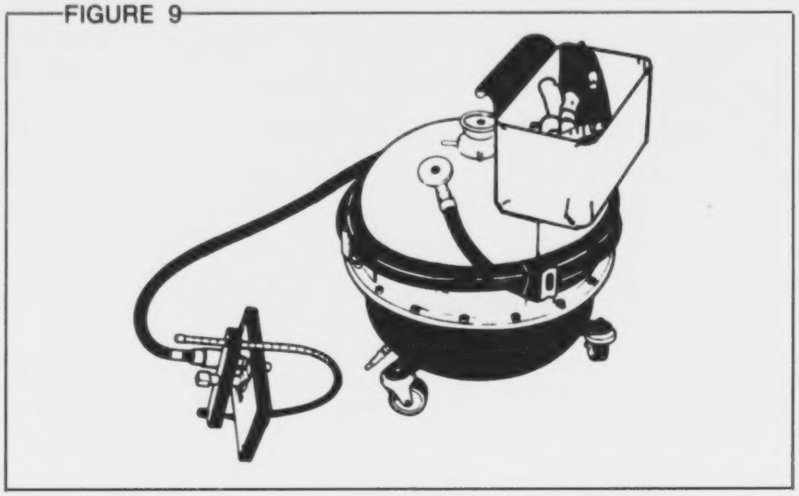
OBJECTIVE 7

Determine the correct specialty tool to use to service hydraulic system and wheel bearings

Brake pressure bleeder — Removes air and contaminants from hydraulic system by supplying pressurized fluid to master cylinder reservoir (Figure 9)

EXAMPLE:

FIGURE 9

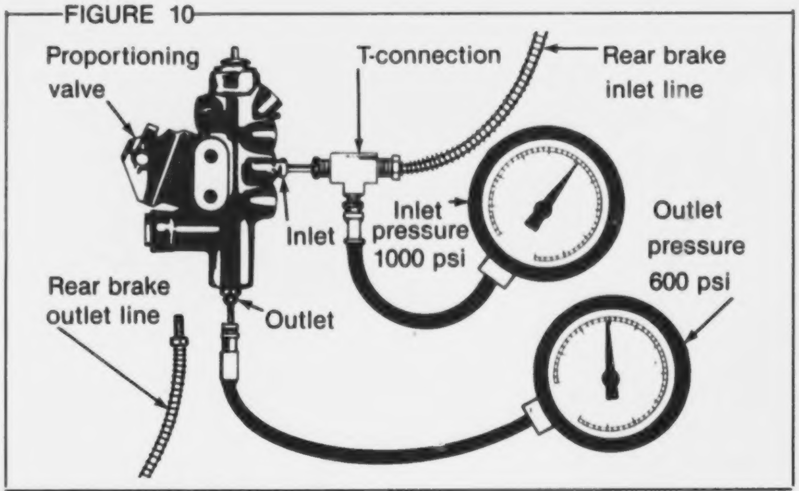


Used with permission of Chrysler Corporation.

Pressure gauge — Used to test operation of proportioning valve (Figure 10)

EXAMPLE:

FIGURE 10


Proportioning valve
T-connection
Rear brake inlet line
Inlet
Inlet pressure 1000 psi
Outlet pressure 600 psi
Rear brake outlet line
Outlet

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service* ©1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

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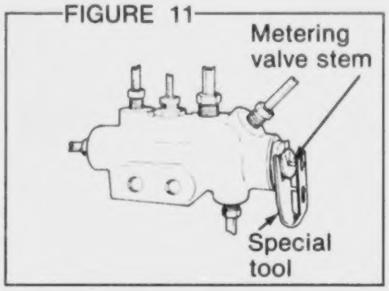
Metering valve tool — Holds metering valve open when pressure bleeding the front brakes (Figure 11)

EXAMPLE:

FIGURE 11

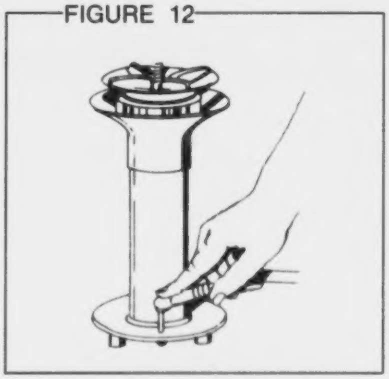


From *Automotive Brake Service, Unit 2: Front Disc Brake Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Wheel bearing packer — Used to force bearing grease into all parts of cone-and-roller bearing assembly (Figure 12)

EXAMPLE:

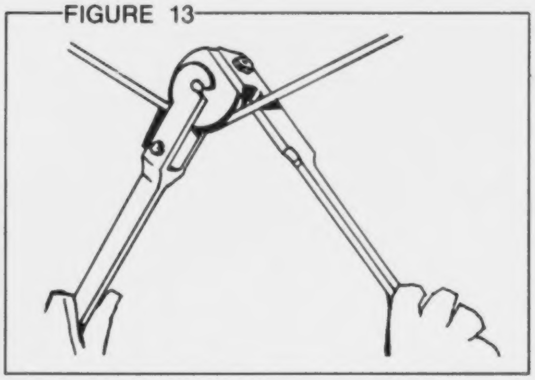
FIGURE 12



Lever-type tubing bender — Shapes flared or unflared metal tubing without kinking it (Figure 13)

EXAMPLE:

FIGURE 13



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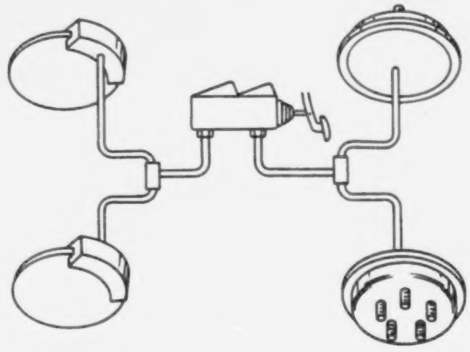
OBJECTIVE 10

Recall dual braking system designs

- Front-to-rear split system (Figure 14)

  NOTE: The front-to-rear split design, in which both front wheels are on one hydraulic circuit and both rear wheels are on another, is the original and most common dual system design on domestic vehicles. If the rear system fails, the front system stops the vehicle.

FIGURE 14

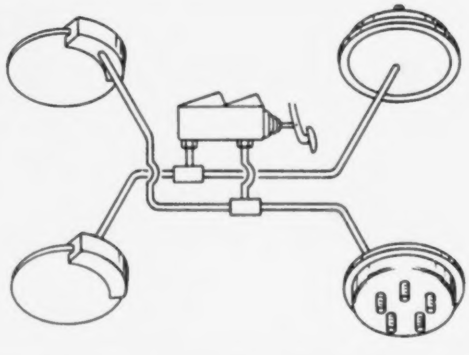


Used with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985*.

- Diagonally split system (Figure 15)

  NOTE: In a diagonally split system, the right front and left rear wheels are on one hydraulic circuit and the left front and right rear wheels are on another. Foreign cars were the first to use this design because it is especially well suited to vehicles with front engines and front-wheel drive. These vehicles do not have enough rear axle weight to provide adequate stopping if failure occurs in the front brake system of front-to-rear split brakes. The diagonally split design, however, provides equal stopping power in the event of failure in either half of the system.

FIGURE 15



Used with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985*.

OBJECTIVE 11 | Evaluate asbestos safety practices

Asbestos

Friction materials such as brake linings and clutch facings often contain asbestos. Millions of asbestos fibers can be released during brake and clutch servicing. Grinding and beveling friction products can cause even higher exposures. Like germs, asbestos fibers are small enough to be invisible and they can remain and accumulate in the lungs. When you see a cloud of dust during brake work, you are seeing clumps containing thousands of fibers.

Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed by everyone inside the garage, including the customers. While lowering exposure lowers risk, *there is no known level of exposure to asbestos below which health effects do not occur*. The EPA has proposed phasing out the use of asbestos products. In situations where asbestos exposures cannot be eliminated entirely—the auto shop, for instance—exposures must be reduced to the lowest possible level.

Asbestos can be carried on work clothing, contaminating the family car and home. This contamination can cause asbestos disease among family members. An ordinary house or shop vacuum cleaner cannot collect these asbestos fibers because the filter is not fine enough to trap them. In fact, an ordinary vacuum cleaner (one that is not equipped with a high-efficiency particulate air, HEPA, filter) is likely to stir up asbestos fibers and scatter them into the air.

Asbestos can also get on a mechanic's hands and be swallowed when the automotive specialist smokes a cigarette or eats. This is a particularly difficult problem for specialists as they often get grease on their hands, and asbestos fibers can stick to the grease.

Until the use of asbestos products is phased out, the best way of limiting health damage is to use proper controls. Effective asbestos containment prevents problems associated with housekeeping and with stirring up settled dust. The best approach is to follow all asbestos safety guidelines designed to contain brake dust and to prevent its release into the shop or garage.

From Environmental Protection Agency Office of Pesticides and Toxic Substances, Asbestos Action Program, *Guidance for Preventing Asbestos Disease Among Auto Mechanics*, June 1986.

- Use the most up-to-date, EPA-approved enclosure-type brake cleaner equipped with a HEPA-type vacuum cleaner filter
- Follow enclosure-equipment installation and use procedures to the letter, making sure that equipment is properly in place before any service begins
- Always follow manufacturer's instructions for changing filter or collection bag
- **Never** use compressed air to clean the brake assembly, your clothing, or the work area

- Do **not** sweep the work area with a broom or garden hose; use a vacuum cleaner equipped with a HEPA filter
- Dispose of asbestos waste in accordance with EPA's asbestos-disposal guidelines
- Whenever possible, use pre-ground, installation-ready brake linings
- Do **not** eat, drink, or smoke in any area where brake work is done
- Wash your hands and face before eating, and wash all exposed skin and change clothes before going home

  NOTE: Your employer should see to the laundering of your work clothes. If possible, work clothes should be laundered at special facilities equipped to wash clothing contaminated with asbestos.

- Wear an air-purifying respirator with HEPA cartridges **only** as secondary protection against accidental disturbance of asbestos dust, and **not** as a substitute for the use of enclosure-type equipment

  NOTE: Air-purifying respirators with HEPA cartridges may be appropriate for *secondary* protection during floor cleaning, filter or collection bag changing, and waste disposal. It should be noted that while NIOSH and EPA do not recommend the use of air-purifying respirators with HEPA cartridges in asbestos environments, various existing regulations currently allow their use.

- Even though asbestos friction materials are being phased out, assume for the sake of caution that *all* such materials contain asbestos, and follow appropriate safety guidelines
- Educate yourself to the dangers of asbestos exposure and take responsibility for your own safety and that of others: Do **not** take a job in a shop that is careless in its asbestos safety procedures, and refuse to work or train in an unsafe environment; your life could depend on it

OBJECTIVE 12

Recognize definitions of terms associated with wheel bearings

Bearing — Part that transmits a load to a support and thus absorbs most of the friction and wear of the moving part

Race — Surface or path on which bearing balls or rollers move

Bearing race (cup) — Part of bearing that contains outer race; installed in hub with a press fit

Bearing cone assembly — Part of roller bearing that contains inner race, roller cage, and rollers; installed on spindle with a push fit

Press fit — Installation of a bearing cup with a tight or interference fit requiring more than hand pressure to install

Push fit — Installation of a bearing cone assembly with a light fit that can be installed with hand pressure

Preload — To adjust bearings so that they will work under mild pressure

Packing — Process of cleaning old grease from bearings and then forcing new wheel bearing grease into openings between races and ball or roller cages; may be done manually or mechanically

End play (bearing) — Amount of axial movement in hub due to clearance in bearings

Viscosity — Thickness of a fluid; resistance to flow

Wheel Bearings

Wheel bearings come in pairs of inner and outer bearings. They allow the wheels of a vehicle to turn freely over thousands of miles by cushioning the contact between the wheel and its spindle. The grease used to lubricate the bearings tends to pick up dust, dirt, and little particles of metal, although the bearings are to some degree protected by the hub and brake drum or rotor. It is important to check the bearings at least as often as the brakes are checked to be sure that the grease has not become fouled. If it has, the dirt particles will act abrasively to wear away the very connection the grease was designed to protect, and the result will be a noisy, grinding ride. A good time to have wheel bearings repacked is when a front-end alignment or brake job is performed, because the wheels will be off anyway and this will eliminate duplicating labor. Front-wheel bearings on a driving hub and wheel bearing assembly are normally not serviced unless specified or when major repairs are needed. Service of rear-wheel bearings on front-wheel-drive vehicles is basically the same as that for front bearings.

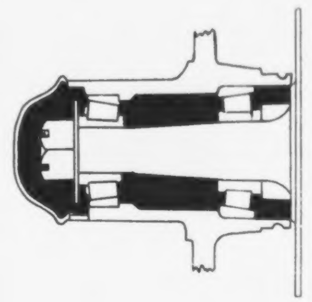
OBJECTIVE 13

Identify types of wheel bearings

- Tapered roller bearings (Figure 16)

NOTE: The tapered roller bearing is the bearing design most commonly used on today's automobiles. Each front-wheel hub normally uses a pair of tapered roller bearings.

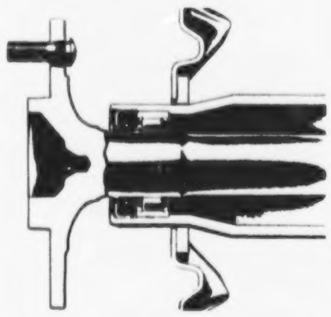
FIGURE 16



- Straight roller bearings (Figure 17)

NOTE: Straight roller-on-shaft bearings are used on rear-wheel assemblies of some medium-to-heavier-weight automobiles.

FIGURE 17

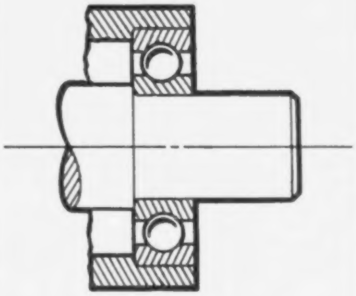


From *Automotive Chassis Systems: Steering Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of General Motors.

- Ball bearings (Figure 18)

  NOTE: Ball bearings are used on the rear wheels of some light vehicles.

FIGURE 18

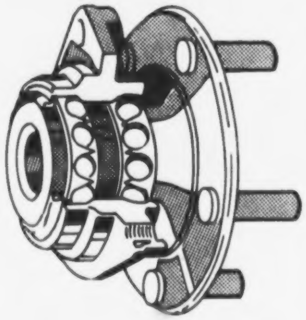


Used with permission of Federal Mogul Corporation.

- Integrated ball bearings (sealed bearings) (Figure 19)

  NOTE: This type of bearing is found primarily on front-wheel-drive vehicles. The inner bearing races are combined with a conventional spindle. The outer bearing races are part of the hub/flange.

FIGURE 19



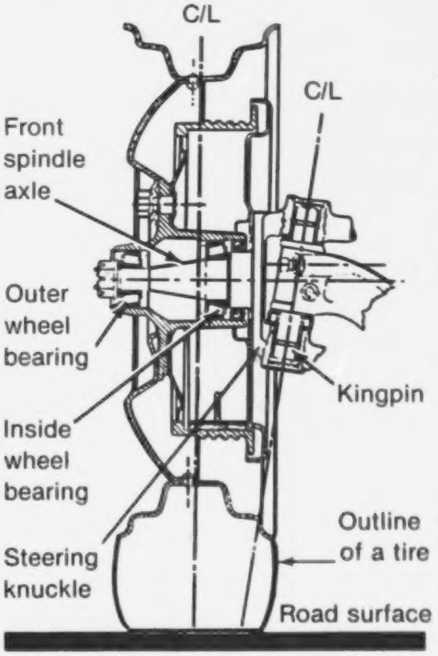
OBJECTIVE 14

Recall the purposes of wheel bearings

- To reduce friction between revolving wheel hub and spindle
- To spread vehicle loads over a larger surface area

NOTE: The wheel bearings transmit the vehicle's radial (vertical) load and thrust (side-to-side) load as the wheels revolve.

Wheel Bearings and Load Lines



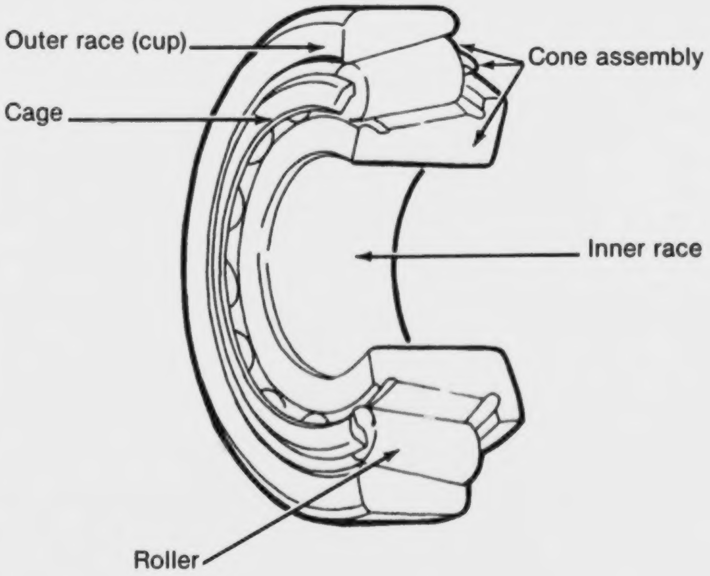
The figure at right illustrates an important principle of mechanical design. After you have removed the front wheel hub from a vehicle, you will notice the tapered design of the front spindle axle. The center-load line of the wheel is almost in line with the larger, inside wheel bearing. The tapered roller bearings and axle spindle are required to support the radial load of the vehicle, reducing the shearing of the spindle. As you examine the illustration, you will observe a center-load line through the kingpin or steering knuckle (ball joint suspension). Both center-load lines are designed to intersect near the road surface in order to reduce the effort required to turn the wheel at the road surface.

Used with permission of Breton Publishers, A Division of Wadsworth, Inc., from *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., by David A. Coghlan, 1985.

OBJECTIVE 15

Recall the parts of a tapered roller wheel bearing assembly

FIGURE 20



Wheel Bearing Noises

On rear-wheel-drive vehicles, loose or rough front wheel bearings produce a noise that may be confused with rear axle noises. The difference is that front wheel bearing noise does not change when the vehicle is coasting or accelerating. A light application of the brake while holding the vehicle's speed constant often causes bearing noise to diminish because this action reduces some of the weight supported by the bearings. In the shop, front wheel bearings may be checked easily for noise by raising the suspected wheel and then spinning it. If the vehicle is equipped with disc brakes, the brake pads must be disengaged from the rotor before performing this check. During a road test, the bearings may be checked by moving the steering wheel to the right and left while listening for noise.

OBJECTIVE 16 Recognize properties of wheel bearing grease

- Is water-resistant
- Is heat-resistant

  NOTE: Wheel bearing grease will not lose its viscosity as the temperature rises.

- Is stable at high temperatures

  NOTE: Wheel bearing grease will not separate at high temperatures.

- Is noncorrosive
- Adheres to friction surfaces

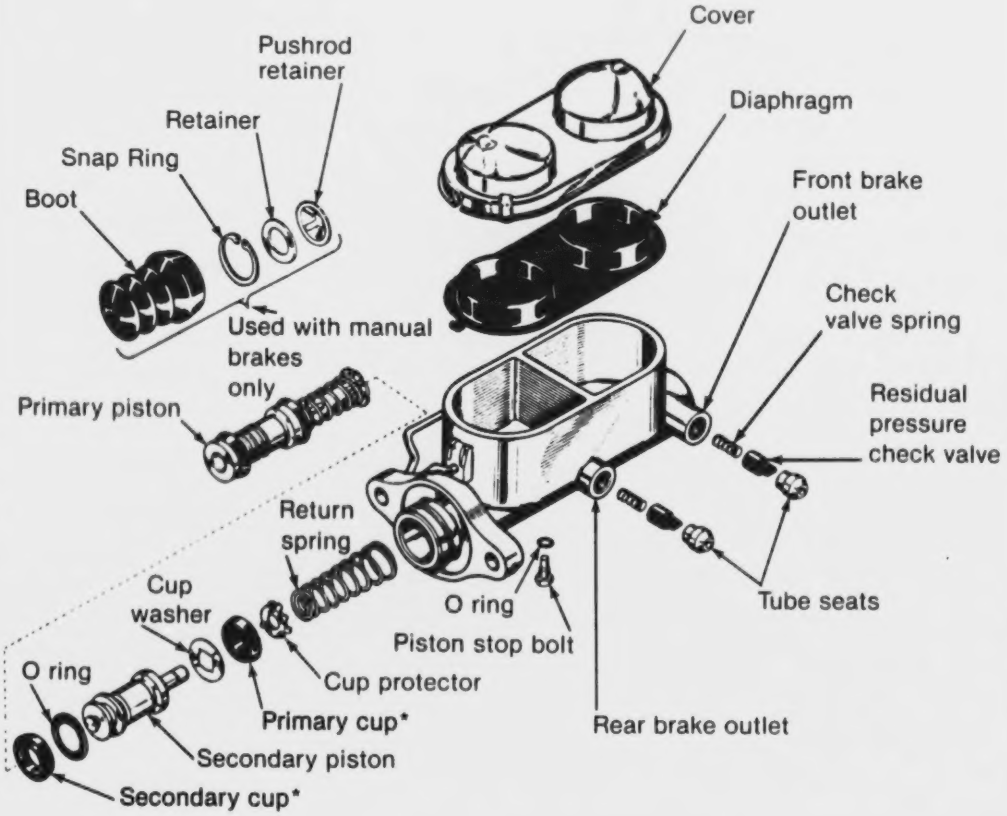
  NOTE: Wheel bearing grease will adhere to metal and will not form acids under adverse conditions.

Wheel Bearing Lubrication

While some rear wheel bearings are automatically lubricated by oil creeping along the axle shaft from the differential, others are sealed and require separate lubrication. Rear axles with seals on the outboard of the bearing usually indicate that the bearing is lubricated by differential oil. Seals in the housing on the inside of the bearing (toward the differential side) must be prelubricated and sealed or repacked at certain intervals. The vehicle manufacturer supplies lubrication charts that should be followed for both type and frequency of lubrication. Front wheel bearings call for the use of a special wheel bearing grease of short fiber and with a high melting point. The high melting point is critical because the brake drums surrounding the wheel bearings sometimes get as hot as 700 degrees Fahrenheit. Not all of this heat is applied to the wheel bearings, but a considerable amount is absorbed by the hubs. If the grease melts, it may get by the oil seal and ruin the brake linings. In this case, the bearings will also be damaged due to loss of lubrication.

OBJECTIVE 20 | Recall the parts of a typical dual master cylinder

FIGURE 21


Cover
Pushrod retainer
Diaphragm
Retainer
Snap Ring
Front brake outlet
Boot
Check valve spring
Used with manual brakes only
Residual pressure check valve
Primary piston
Return spring
Cup washer
O ring
Tube seats
Piston stop bolt
O ring
Cup protector
Primary cup*
Rear brake outlet
Secondary piston
Secondary cup*

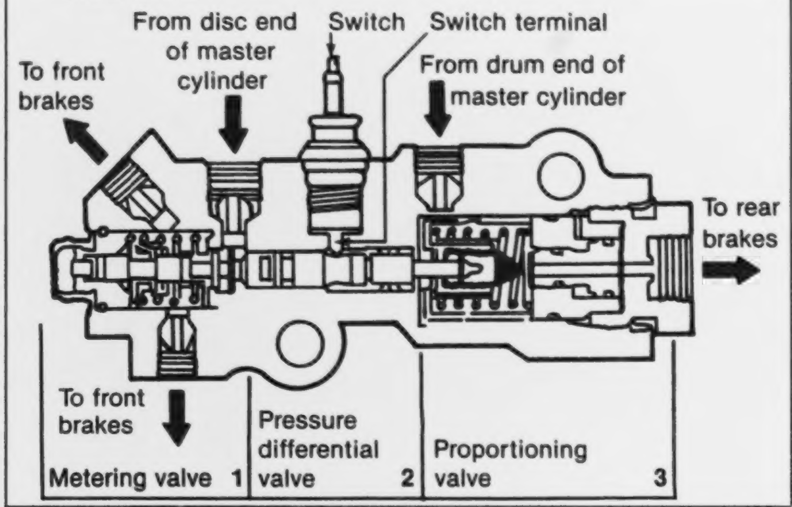
*Note position of secondary cup in relation to primary cup. They face opposite directions.

Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

OBJECTIVE 25

Recognize combination valve components and functions

FIGURE 22


From disc end of master cylinder
Switch
Switch terminal
To front brakes
From drum end of master cylinder
To rear brakes
To front brakes
Pressure differential valve 2
Proportioning valve 3
Metering valve 1

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service* ©1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

1. **Metering valve** — Delays hydraulic pressure to front brakes until after rear brakes are applied
2. **Pressure differential valve** — Turns on a warning light if the pressure drops in one part of the system
3. **Proportioning valve** — Reduces pressure to rear wheels during hard braking

Functions of the Combination Valve

Proper operation of combination valve components is very important. For instance, the metering valve is tied into the brake lines leading to the front brakes. If the front brakes apply before the rear brakes, directional control becomes difficult. In an emergency, the vehicle could spin. The metering valve assures that the front wheels will apply just *after* the rear brakes.

In addition, during hard braking, when the driver makes a panic stop, the vehicle dips and the rear end comes up. Because more weight is transferred to the front of the vehicle, the rear wheels are more likely to lock. By reducing pressure to the rear brakes, the proportioning valve prevents this type of lockup.

Not only does the combination valve perform both of these functions, but it also has a brake warning light switch that actuates a red light on the instrument panel. This light alerts the driver to the failure of one or the other of these brake systems.

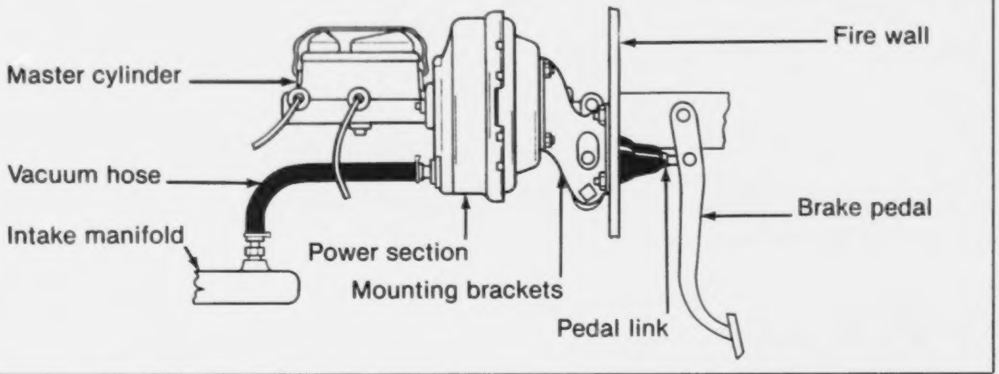
OBJECTIVE 30

Recognize types of power-assist units

- Vacuum power-assist unit (Figure 23)

  NOTE: All power brake boosters, regardless of design, function to reduce braking effort and to increase force to the brake system. The vacuum power-assist unit is the type of power booster most commonly found on today's vehicles.

FIGURE 23

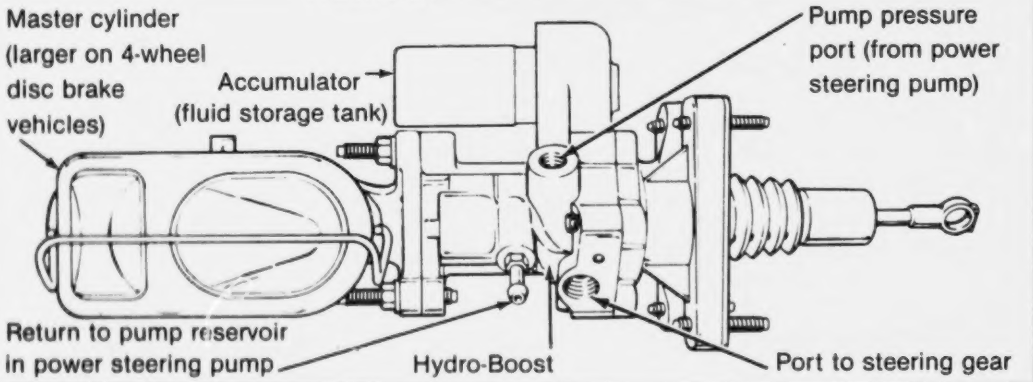

Master cylinder
Vacuum hose
Intake manifold
Power section
Mounting brackets
Pedal link
Fire wall
Brake pedal

Used with permission of Allied Aftermarket.

- Hydraulic power-assist unit with mechanical pump (Figure 24)

  NOTE: General Motors makes two designs of hydraulic power-assist units with mechanical pumps powered by hydraulic pressure from the power steering pump: Hydro-Boost I and Hydro-Boost II. Hydro-Boost I units have an accumulator separate from the booster. Hydro-Boost II designs incorporate the accumulator into the power piston. Figure 24 is an external view of a unit with separate accumulator.

FIGURE 24

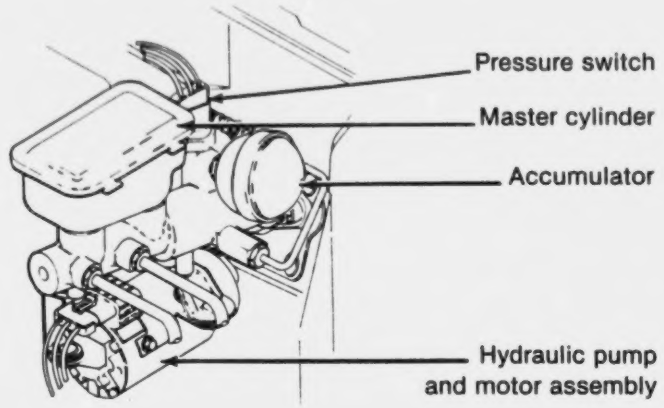

Master cylinder (larger on 4-wheel disc brake vehicles)
Accumulator (fluid storage tank)
Pump pressure port (from power steering pump)
Return to pump reservoir in power steering pump
Hydro-Boost
Port to steering gear

From *Automotive Chassis Systems: Steering Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Ford Motor Company.

- Hydraulic power-assist unit with electrical pump (Figure 25)

  NOTE: This fairly new type of power-assist unit uses an electric motor rather than the power steering pump to drive its hydraulic pump. This design is presently found on some General Motors and Ford vehicles.

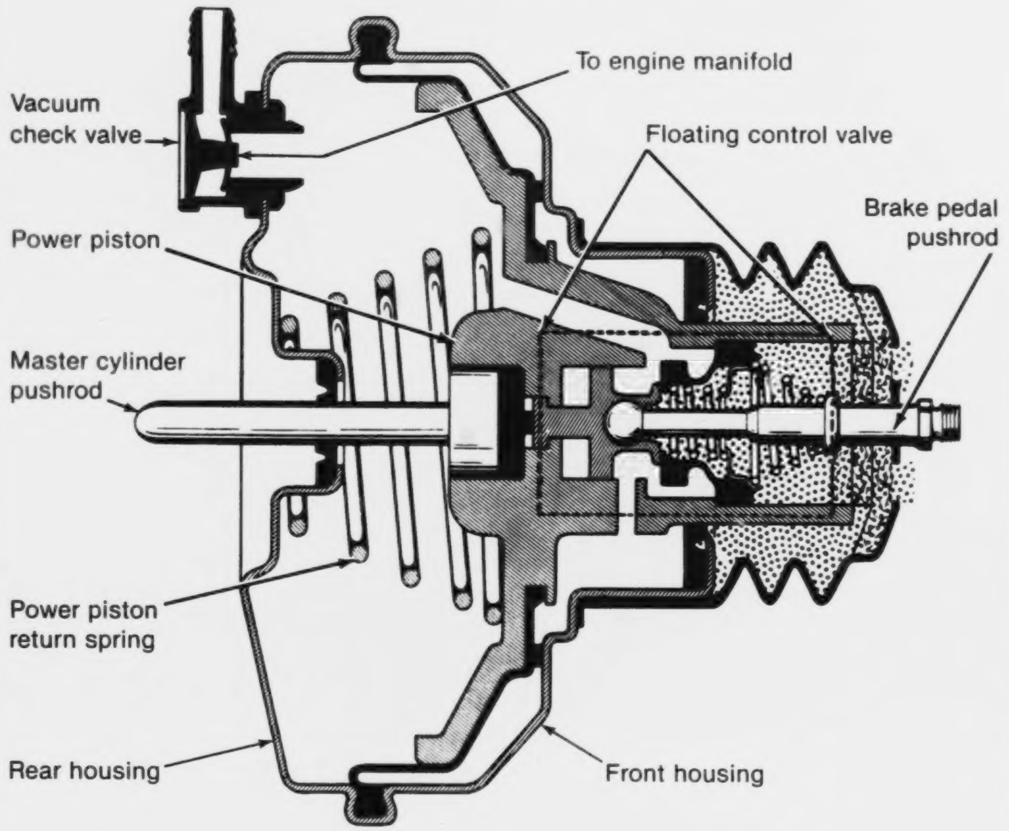
FIGURE 25


Pressure switch
Master cylinder
Accumulator
Hydraulic pump and motor assembly

Used with permission of General Motors Corporation, Delco Moraine Division.

OBJECTIVE 31 | Recall the major parts of a vacuum power-assist unit

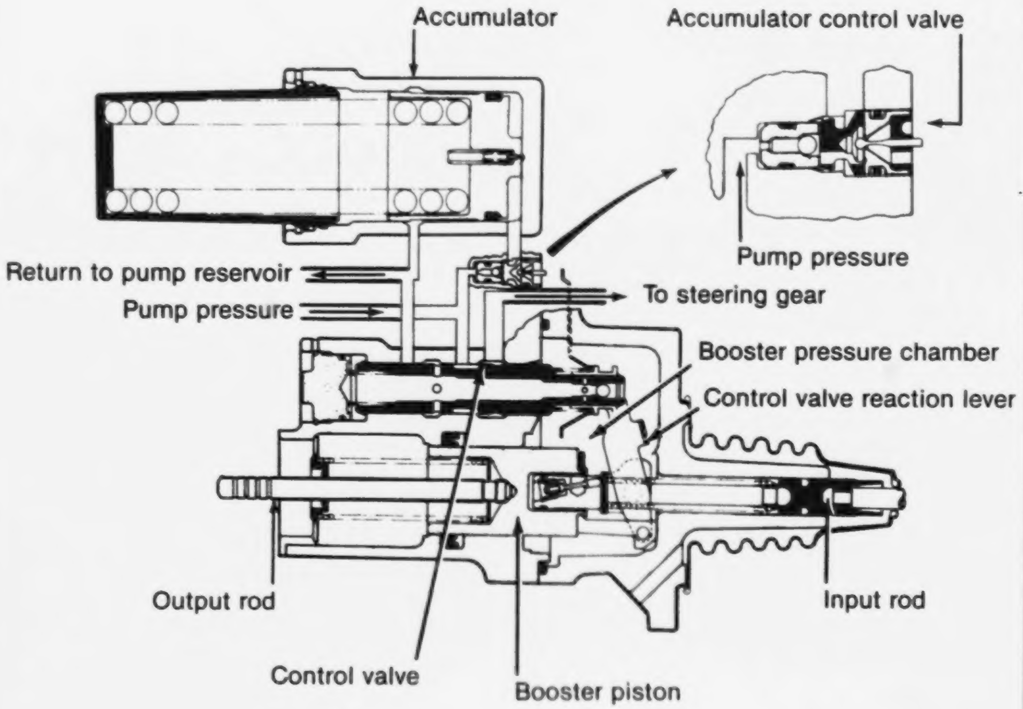
FIGURE 26


To engine manifold
Vacuum check valve
Floating control valve
Brake pedal pushrod
Power piston
Master cylinder pushrod
Power piston return spring
Rear housing
Front housing

OBJECTIVE 32

Recall the major parts of a hydraulic power-assist unit (mechanical pump)

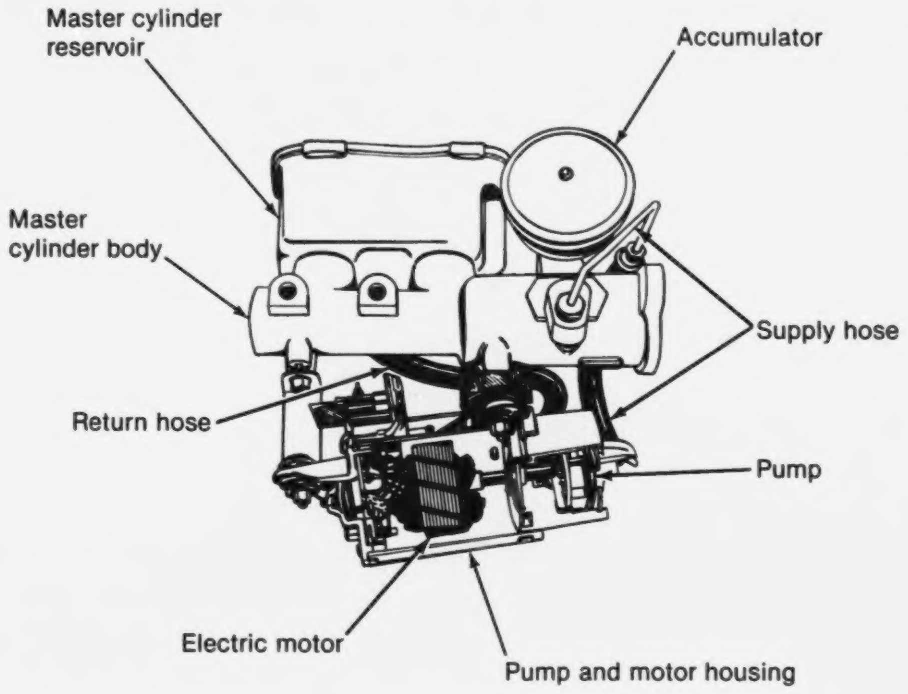
FIGURE 27


Accumulator
Accumulator control valve
Pump pressure
Return to pump reservoir
Pump pressure
To steering gear
Booster pressure chamber
Control valve reaction lever
Output rod
Input rod
Control valve
Booster piston

115

OBJECTIVE 33 | Recall the major parts of a hydraulic power-assist unit (electrical pump)

FIGURE 28


Master cylinder reservoir
Accumulator
Master cylinder body
Supply hose
Return hose
Pump
Electric motor
Pump and motor housing

OBJECTIVE 39

Recall functions of major components of a brake antiskid system

NOTE: Special skid-control brake systems (sometimes called *brake antilock systems*) use electronics to sense wheel lockup and modulate braking at the wheel many times per second. While these systems may vary in design, they have in common the following basic components.

Electronic controller — Monitors system operation during normal driving as well as during antilock braking

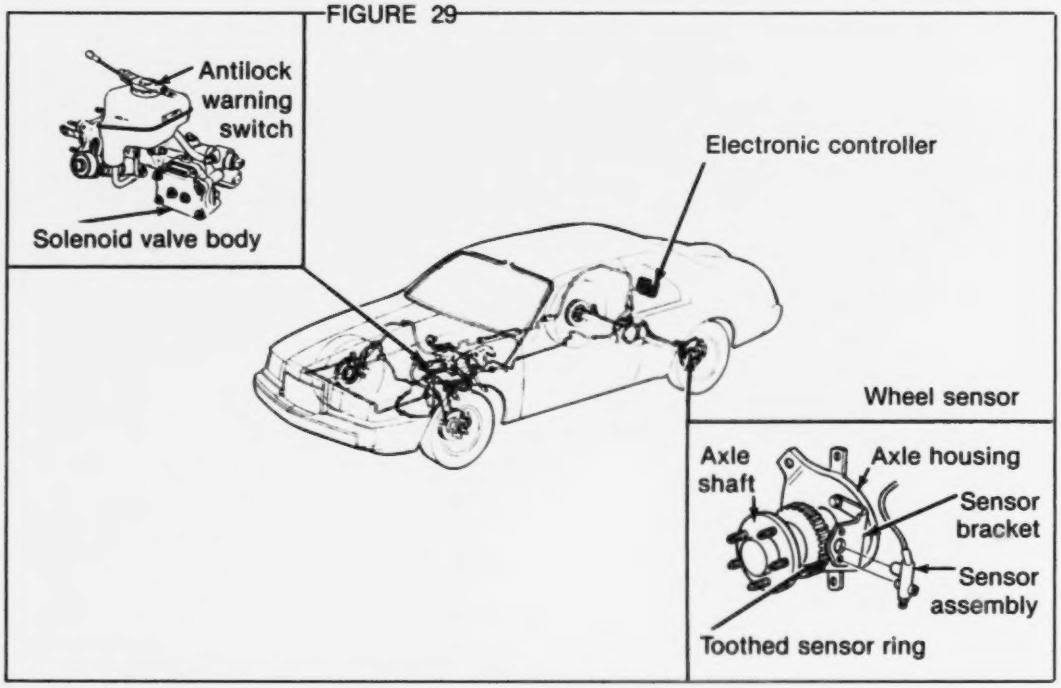
Wheel sensor — Monitors wheel for lockup and transmits lock-up condition to controller

Solenoid valve — Controls pressure in lock-up situations

Antilock warning switch — Activates light on dash if system malfunctions

EXAMPLE:

FIGURE 29


Antilock warning switch
Solenoid valve body
Electronic controller
Wheel sensor
Axle shaft
Axle housing
Sensor bracket
Sensor assembly
Toothed sensor ring

From *Mitchell Chassis Service Repair Domestic Cars: 1985 Supplement*. Adapted with permission of Ford Motor Company.

STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 1

Diagnostic Chart for Basic Hydraulic System Problems

NOTE: This chart covers conditions caused by brake system hydraulic problems. However, some of these conditions may result from other malfunctions, such as brake mechanical problems, wheel bearing defects, or problems in the suspension or steering systems. This chart is intended to help you diagnose suspected brake hydraulic system problems. Other procedures may be required if the problem is elsewhere.

Condition	Probable cause	Corrective action
Low pedal, excessive pedal travel	Leak in hydraulic system	Check master cylinder, wheel cylinders, calipers, tubes, and hoses for leakage; repair or replace faulty parts
	Air in hydraulic system	Bleed hydraulic system
	Poor-quality brake fluid (low boiling point)	Flush hydraulic system and fill with approved brake fluid
	Low brake fluid in master cylinder reservoir	Fill master cylinder and bleed hydraulic system
	Weak brake hoses that expand under pressure	Replace defective hoses
	Improperly adjusted manual master cylinder pushrod	Adjust pushrod (if vehicle has adjustable pushrod)
	Residual pressure check valves not holding pressure in lines	Repair or replace master cylinder
Springy or spongy pedal	Poor-quality brake fluid (low boiling point)	Flush hydraulic system and fill with approved brake fluid
	Weak brake hoses that expand under pressure	Replace defective hoses
	Air in hydraulic system	Bleed hydraulic system

Condition	Probable cause	Corrective action
Hard pedal (excessive pedal pressure needed to stop vehicle)	Clogged master cylinder tubes or hoses	Replace tubes or hoses as necessary
	Frozen master cylinder piston(s)	Repair or replace master cylinder
Grabby brakes, sensitive brakes, braking too severe	Rough or corroded master cylinder bore	Recondition bore or replace master cylinder
Car pulls to one side	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Sticking caliper piston	Repair or replace caliper
Decreasing brake pedal travel	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Plugged master cylinder compensating ports	Repair or replace master cylinder
	Swollen master cylinder cups	Repair or replace master cylinder, flush hydraulic system, and fill with approved brake fluid
All brakes drag, car does not roll freely (but brake adjustment is correct)	Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace all rubber parts; flush hydraulic system and fill with approved brake fluid
	Plugged master cylinder compensating ports	Repair or replace master cylinder

Condition	Probable cause	Corrective action
One brake drags, one wheel drags	Sticking wheel cylinder pistons	Repair or replace wheel cylinders
	Swollen wheel cylinder cups	Repair or replace wheel cylinder, flush hydraulic system, and fill with approved brake fluid
	Sticking caliper piston	Repair or replace caliper
	Swollen caliper piston seal	Repair caliper, flush hydraulic system, and fill with approved brake fluid
	Defective brake hose or hydraulic tube preventing return of brake fluid	Replace defective hose or tube as necessary

STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 2

Diagnostic Chart for Vacuum Power-Assist Units

Condition	Probable cause	Corrective action
Hard pedal	Faulty vacuum check valve	Do **not** repair or oil valve; replace it
	Engine intake manifold doesn't have sufficient (17 Hg to 20 Hg/ 432 - 508 mm) vacuum	Tune engine, repair and adjust and obtain proper vacuum
	Plugged breather in power unit	Clean or replace
	Vacuum hoses and line fittings plugged	Clean passages, or replace faulty parts
	External vacuum leaks in reserve tank and loose vacuum connections	Replace with new tank; tighten all vacuum connections
	Restricted power brake air filter	Wash filter in non-oil-based cleaning fluid; allow to dry before replacing, or install a new filter
	Rusted or dry vacuum piston	Lubricate vacuum piston, or replace the power brake unit
	Collapsed vacuum hose or dented tubing from intake manifold to power brake unit	Replace with new hose or tubing
Pedal goes to floor	Low fluid level, or external hydraulic fluid leaks	Check for leaks, and repair as necessary; replenish fluid level
	Faulty residual check valve, primary cup, or contamination or rust	Flush system, replace defective parts, or replace power brake unit if defective

Condition	Probable cause	Corrective action
Pedal fails (or is slow) to return	Plugged breather in power brake unit	Clean or replace
	Plugged compensator port in power brake unit	Adjust pedal linkage, flush system, or replace power brake unit
	Piston stroke interference, or faulty residual check valve, or broken piston return spring, or sticky slide valve in power brake unit	Replace power brake unit; do **not** oil slide valve
	Excessive hydraulic seal friction in wheel cylinders and power brake unit	Replace wheel cylinders or power brake unit
Sensitive (grabby) brakes	Reaction diaphragm leakage, or sticky slide valve action, or closed or restricted atmospheric passage in vacuum piston assembly, or binding rubber seals in power brake unit	Replace power brake unit

STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 3

Diagnostic Chart for Hydraulic Power-Assist Units with Mechanical Pumps

CAUTION

Power steering fluid and brake fluid should **not** be mixed. If brake seals contact steering fluid, or steering seals contact brake fluid, seal damage will result.

Condition	Probable cause	Corrective action
Slow brake pedal return	Excessive seal friction in booster unit	Overhaul with new seal kit
	Spool return and/or piston return spring broken	Install appropriate new spring(s)
	Faulty spool action	Flush steering system while pumping brake pedal
	Clogged return line from booster to pump reservoir	Replace line
Excessive brake pedal effort	Power steering pump belt loose or broken	Tighten or replace belt
	Leaks in power steering, booster or accumulator connections, tube fittings, or hoses	Tighten fittings and/or replace tube seats and faulty parts
	External leakage at accumulator	Replace retainer and O ring
	Power steering reservoir empty	Fill reservoir, and check for external leaks
	Leakage at booster flange vent due to faulty booster piston seal, or leakage between housing and cover due to faulty booster cover seal	Overhaul with appropriate new seal kit
	Faulty booster spool plug seal	Overhaul with new spool plug seal kit
	Faulty booster input rod seal with leakage at input rod end	Replace booster

Condition	Probable cause	Corrective action
System does not hold charge	Accumulator leak down or steering power-assist system contaminated	Flush steering system while pumping brake pedal
	Internal leakage in accumulator system	Overhaul system using accumulator rebuild and seal kit
Pedal vibrates and booster chatters	Loose power steering pump belt	Tighten belt
	Faulty spool operation due to contamination in system	Flush steering system while pumping brake pedal
	Low fluid level in power steering pump reservoir	Fill reservoir adequately, and check for external leaks
Brakes grab	Spool return spring damaged	Replace spring
	Faulty spool operation caused by contamination in system	Flush steering system while pumping brake pedal

STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 4

Diagnostic Chart for Hydraulic Power-Assist Units with Electrical Pumps

CAUTION

Failure to fully depressurize an electrically driven hydraulic assist unit before performing service operations could result in injury to brakes specialist and damage to painted surfaces.

Condition	Probable cause	Corrective action
Brake warning light on after engine start	Parking brake applied	Temporarily release parking brake
	Partial failure in brake hydraulic pressure circuit	Troubleshoot circuit; repair or replace components as necessary
	Electrical failure	Check ignition, fuse, pressure switch, motor/relay AC terminals, connectors, wiring; replace as necessary
	Low fluid in reservoir	Fill and bleed system
	Faulty warning light pressure switch	Check switch; replace as necessary
Excessive brake travel, hard brake pedal, excessive stopping distances, early wheel lock-up tendency	Partial failure in brake hydraulic pressure circuit	Troubleshoot pressure circuit; repair or replace components as necessary
Pump motor will not run	Electrical failure	Check ignition, fuse, pressure switch, motor/relay AC terminals, connectors, wiring; replace as necessary

Condition	Probable cause	Corrective action
Pump motor runs, but does not shut off in 20 seconds	Low fluid in reservoir	Fill and bleed system
	Faulty power piston operation	Check reservoir port for backflow; replace power piston
	Low pump pressure	Check pressure line for obstruction; replace pump and motor if necessary
	High pump pressure	Replace switch if higher than normal; replace pump if lower than normal cutoff
Pump self-cycles without brake application	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; *if* low, replace accumulator and recheck self-cycle
Pump self-cycles while holding steady brake application	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; *if* low, replace accumulator and self-cycle
	Faulty power piston operation	Check reservoir port for fluid backflow; replace power piston
Pump reservoir does not cycle between full and nearly empty when accumulator is fully charged and fully depressurized	Air in fluid	Turn ignition ON and cycle pump 5 to 10 times to remove air by opening and closing bleeder valve
	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; *if* low, replace accumulator
Pump reservoir fluid level does not cycle between half full and nearly empty at pressure switch limits	Pump reservoir not at FULL when accumulator is fully depressurized	Fill reservoir with brake fluid
	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; *if* low, replace accumulator

Condition	Probable cause	Corrective action
Fluid leakage	Worn or loose O rings, grommets, seals, hoses, clamps, or connectors	Wipe components clean, check for leaks, replace damaged or worn components
	Loose reservoir cover or diaphragm	Repair or replace as necessary
	Excess fluid fill in reservoir when accumulator fully depressurized	Check pump pressure; replace switch if necessary
Pump cycle time at pressure switch limits exceeds 10 seconds	Air in system	Turn ignition ON and cycle pump 5 to 10 times to remove air by opening and closing bleeder valve
	Obstructed pump inlet or outlet	Flush system; replace pump and motor if necessary
	Abnormal pressure switch points	Replace pressure switch
	Faulty pump	Replace pump and motor

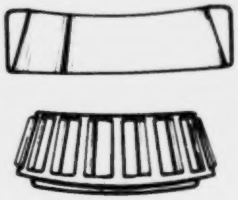
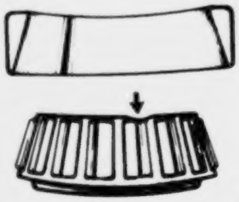
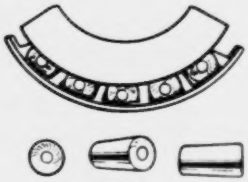
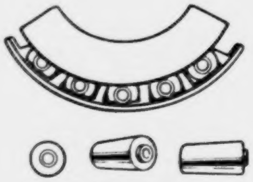
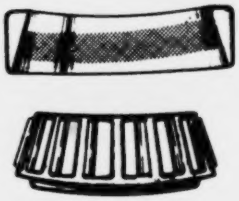
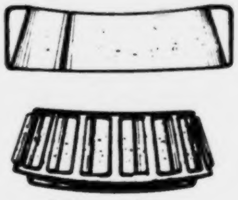
From *1986 Chevrolet Shop Manual*. Adapted with permission of General Motors Corporation, Delco Moraine Division.

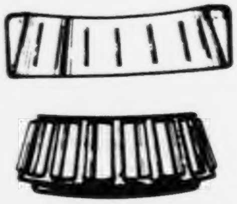
STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 5

Wheel Bearing Inspection Chart

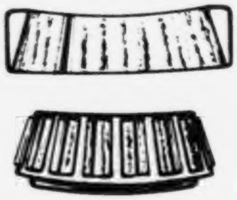
 **Good bearing**	 **Bent cage** Cage damage due to improper handling or tool usage. Replace bearing.
 **Galling** Metal smears on roller ends due to overheat, lubricant failure, or overload. Replace bearing—check seals and check for proper lubrication.	 **Abrasive step wear** Pattern on roller ends caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough, or noisy.
 **Misalignment** Outer race misalignment due to foreign object. Clean related parts and replace bearing. Make sure races are properly seated.	 **Indentations** Surface depressions on race and rollers caused by hard particles of foreign material. Clean all parts and housings, check seals and replace bearings if rough or noisy.



Brinelling

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

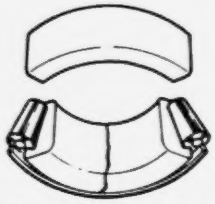
Replace bearing if rough or noisy.



Etching

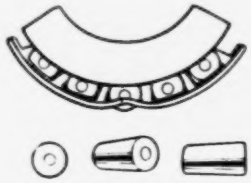
Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings—check seals and check for proper lubrication.



Cracked inner race

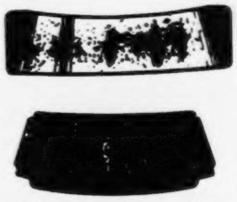
Race cracked due to improper fit, cocking, or poor bearing seats.



Bent cage

Cage damage due to improper handling or tool usage.

Replace bearing.



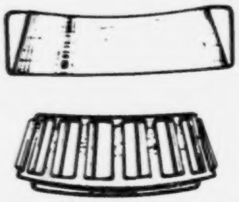
Heat discoloration

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubricant.

Excessive heat can cause softening of races or rollers.

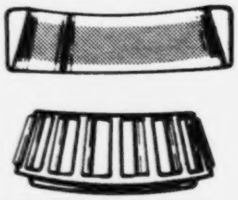
To check for loss of temper on races or rollers a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas, a file drawn over a hard part will glide readily with no metal cutting.

Replace bearings if overheating damage is indicated. Check seals and other parts.



Cage wear

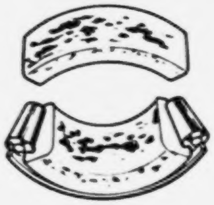
Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication. Check seals and replace bearings.



Abrasive roller wear

Pattern on races and rollers caused by fine abrasives.

Clean all parts and housings, check seals and bearings and replace if leaking, rough, or noisy.

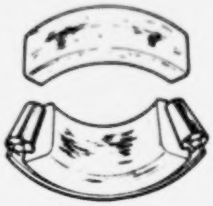


Smears

Smearing of metal due to slippage, slippage can be caused by poor fits, lubrication, overheating, overloads or handling damage.

Replace bearings, clean related parts and check for proper fit and lubrication.

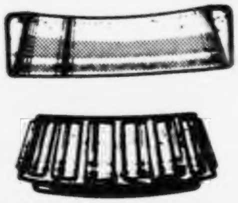
Replace shaft if damaged.



Frettage

Corrosion set up by small relative movement of parts with no lubrication.

Replace bearing. Clean related parts. Check seals and check for proper lubrication.

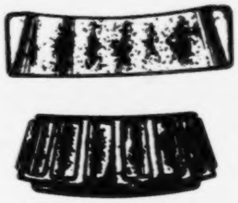


Stain discoloration

Discoloration can range from light brown to black caused by incorrect lubricant or moisture.

Reuse bearings if stains can be removed by light polishing or if no evidence of overheating is observed.

Check seals and related parts for damage.



Fatigue spalling

Flaking of surface metal resulting from fatigue.

Replace bearing—clean all related parts.

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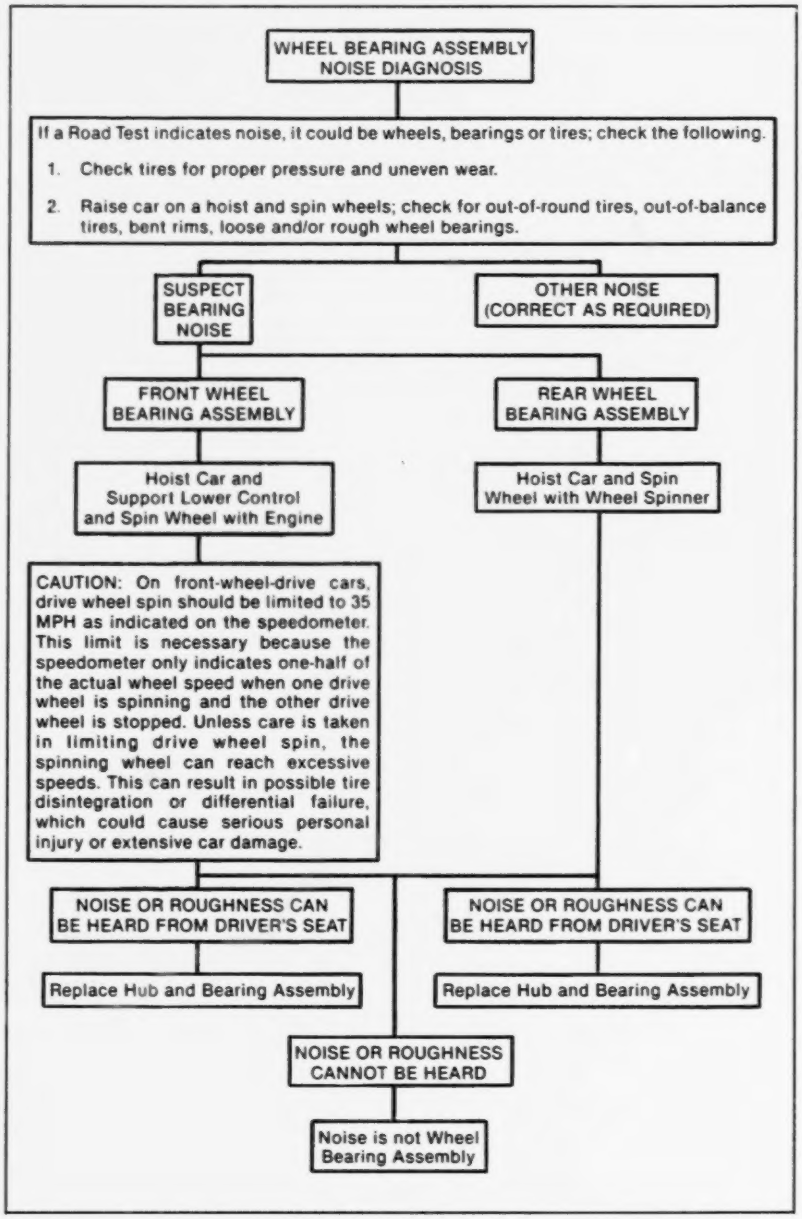
SUPPLEMENT 6

Diagnostic Chart for Sealed Wheel Bearings


WHEEL BEARING ASSEMBLY NOISE DIAGNOSIS
SUSPECT BEARING NOISE
OTHER NOISE (CORRECT AS REQUIRED)
FRONT WHEEL BEARING ASSEMBLY
REAR WHEEL BEARING ASSEMBLY
Hoist Car and Support Lower Control and Spin Wheel with Engine
Hoist Car and Spin Wheel with Wheel Spinner
NOISE OR ROUGHNESS CAN BE HEARD FROM DRIVER'S SEAT
Replace Hub and Bearing Assembly
NOISE OR ROUGHNESS CAN BE HEARD FROM DRIVER'S SEAT
Replace Hub and Bearing Assembly
NOISE OR ROUGHNESS CANNOT BE HEARD
Noise is not Wheel Bearing Assembly

If a Road Test indicates noise, it could be wheels, bearings or tires; check the following.

1. Check tires for proper pressure and uneven wear.
2. Raise car on a hoist and spin wheels; check for out-of-round tires, out-of-balance tires, bent rims, loose and/or rough wheel bearings.

CAUTION: On front-wheel-drive cars, drive wheel spin should be limited to 35 MPH as indicated on the speedometer. This limit is necessary because the speedometer only indicates one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Unless care is taken in limiting drive wheel spin, the spinning wheel can reach excessive speeds. This can result in possible tire disintegration or differential failure, which could cause serious personal injury or extensive car damage.

WHEEL BEARING ASSEMBLY LOOSENESS DIAGNOSIS

DRUM BRAKE

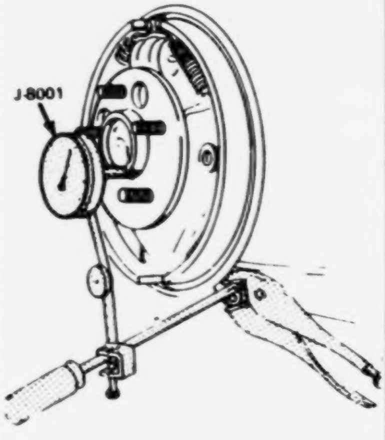
Mount dial indicator as shown below. Grasp bearing flange and, using a push-pull movement, note the indicator readings.

If looseness exceeds .1270 mm (.005"), replace hub and bearing assembly.

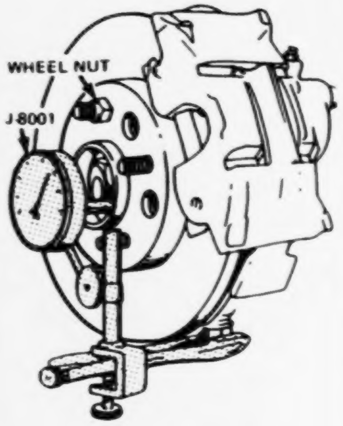
DISC BRAKE

Free the shoes from the disc or remove calipers. Reinstall 2 wheel nuts to secure disc to bearing. Mount dial indicator as shown below. Grasp disc and use a push-pull movement.

If looseness exceeds .1270 mm (.005"), replace hub and bearing assembly.



EXAMPLE OF MOUNTING
DIAL INDICATOR—DRUM BRAKES



EXAMPLE OF MOUNTING
DIAL INDICATOR—DISC BRAKES

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STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 7

Wheel Bearing Problems

Listed below are driving problems that may result from defective or improperly installed wheel bearings. Problems that result from defective wheel bearings can be solved only by replacing the bearing. Those caused by improper installations must be corrected by making a proper installation, such as through adjusting the bearing. Often improper installations will lead to bearing damage, meaning that the bearing must be replaced anyway. Many of the driving problems listed may be caused by other conditions, such as worn suspension parts or defective brakes. The service specialist should use this information as just another clue in analyzing problem situations.

Loose wheel bearings can cause	• Vehicle to pull to one side • Chatter • Uneven braking • Shimmy • Too much play in the steering system
Overtightened wheel bearings can cause	• Noise • Uneven braking • Overheating of the wheel and bearing • Vehicle to pull to one side
Damaged wheel bearings can cause	• Noise • Shimmy in affected wheel • Vehicle to pull to one side
Worn wheel bearings can cause	• Noise

NOTE: Excessively worn bearings may give the same indications as loose bearings.

STUDENT SUPPLEMENTS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

SUPPLEMENT 8

Diagnostic Chart for Stop Lights

Condition	Probable cause	Corrective action
One bulb inoperative	Bulb burned out	Replace bulb
One side inoperative	Loose connection, open wiring, defective bulb	Turn on directional signal; *if* light does not operate, check bulbs; *if* bulbs are okay, secure all connections; *if* light still does not operate, use test light and check for open wiring
	Defective directional signal switch or cancelling cam	*If* light will operate by turning on directional signal, switch is not centering properly during cancelling operation; replace defective cancelling cam or directional signal switch
All lights inoperative	Blown fuse	Replace fuse; *if* new fuse blows, repair short-to-ground in circuit between fuse and lights
	Stop switch maladjusted or defective	Check stop switch; adjust or replace as necessary
Lights will not turn off	Stop switch maladjusted or defective	Readjust switch; *if* switch still malfunctions, replace it

ASSIGNMENT SHEET 1

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 29

Diagnose brake system hydraulic and wheel bearing problems

Name ______________________________ Score ______________

INTRODUCTION

Proper diagnosis of a vehicle's hydraulic brake system is extremely important. In order for a vehicle's brake system to operate properly, the hydraulic system must be trouble-free and in good repair. Service to the hydraulic system is quite simple, generally requiring the brakes specialist to adjust brake fluid levels, bleed the system, or replace faulty components. In order to service the hydraulic system, however, the brakes specialist must first be able to determine the cause of the problem and the corrective action needed.

DIRECTIONS

Given below and on the following pages are "customer complaints" and problems that indicate hydraulic or wheel bearing trouble. Normally, the specialist would verify the customer's complaint by test driving the vehicle to check brake performance and to determine the need for service. Since a test drive is not practical here, base your diagnosis on the customer's descriptions or on the problems described, and refer to the diagnostic charts in Student Supplements 1, 5, 6, and 7 to determine possible causes and the corrective actions needed.

1. **Customer complaint:** When I apply the brakes, the car pulls to the right. I can't get a straight-line stop. (Four-wheel disc brake vehicle)

   Possible cause(s): ______________________________

   ____

   ____

   ____

   Corrective action(s): ______________________________

   ____

   ____

   ____

2. **Customer complaint:** There is something wrong with the brake pedal. It is so hard that I have to really tromp on it in order to stop the car.

Possible cause(s): ____

____

____

____

Corrective action(s): ____

____

____

____

3. **Customer complaint:** My husband changed the brake fluid last week, and ever since, the brake pedal has felt funny—kind of bouncy and mushy.

Possible cause(s): ____

____

____

____

Corrective action(s): ____

____

____

____

4. **Customer complaint:** When I step on the brake pedal, the pedal doesn't seem to go down as far as it used to.

Possible cause(s): ____

____

____

____

Corrective action(s): ____

____

____

____

5. **Customer complaint:** There is something wrong with my brakes. When I apply the brakes, the car seems to jerk, and I can't get it to come to a smooth stop.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

____

____

____

6. **Customer complaint:** I just had my brakes adjusted last week, but now it feels as though the brakes are still on a little, even after I remove my foot from the brake pedal.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

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____

____

7. **Customer complaint:** I can hear an odd type of scraping noise when driving.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

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____

____

8. **Problem:** You have removed the wheel bearings, and upon inspection you discover that the roller ends contain galling (metal smears).

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

____

____

____

9. **Problem:** When servicing the wheel bearings, you notice that the cage outside diameter shows wear.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

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____

____

10. **Problem:** Upon inspection of the wheel bearing assembly, you discover a cracked inner race.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

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____

____

11. **Problem:** You are inspecting the wheel bearings and discover frettage (corrosion) on the race.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

____

____

____

ASSIGNMENT SHEET 2

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 34

Diagnose power-assist unit problems

Name ______________________________ Score ______________

INTRODUCTION

Power brakes have gained wide acceptance with car buyers because of the reduced driver effort that such brakes require. Modern power-assist units have proven to be relatively trouble-free, but certain brake problems can be caused by malfunctioning or defective power-assist units.

Remember that the hydraulic and mechanical problems found in conventional brake systems also may occur in power brake systems, and so the problems associated with conventional systems may also have to be checked for during the inspection of the power-assist unit.

DIRECTIONS

The following questions are multiple-choice-type questions, each with three possible answers. Read each question carefully and then select the answer that is *most* correct. Write the correct letters in the blanks. Refer to Student Supplements 2 through 4 if necessary.

_____1. A vehicle is equipped with hydraulic power brakes. The owner says that excessive brake pedal effort is required to stop the vehicle. Which of the following is the *most likely* cause?

a. Excessive seal friction in booster
b. Broken spool return spring
c. Loose or broken power steering pump belt

_____2. A vehicle is equipped with vacuum power brakes. The owner says that excessive pedal effort is required when the brakes are applied. Which of the following would **not** be a likely cause?

a. Plugged breather in power brake unit
b. Broken piston return spring
c. Collapsed vacuum hose or dented tubing from intake manifold to power brake unit

_____3. You are servicing a 1987 T-Bird with an electrically driven hydraulic power-assist unit and find that the pump cycle time at pressure switch limits exceeds 10 seconds. Which of the following is the *most likely* cause?

a. Incorrect accumulator precharge pressure
b. Electrical failure
c. Air in system

_____4. You have just inspected a vehicle with vacuum power brakes and determined that a sticky slide valve in the power brake unit was the cause of the brake pedal failing to release. Which of the following would be the proper corrective measure?

a. Replace power brake unit
b. Oil slide valve
c. Wash slide valve and replace brake fluid

_____5. You have just determined that the pedal vibration on a vehicle equipped with hydraulic brakes was caused by low fluid level in the power steering pump reservoir. Which of the following would be the proper corrective measure?

a. Flush steering system while pumping brake pedal
b. Fill reservoir with brake fluid and check for leaks
c. Fill reservoir with power steering fluid and check for leaks

_____6. While road testing a vehicle equipped with a hydraulic power-assist unit to verify a customer compliant, you notice that the brakes grab. Which of the following would be the *most likely* cause?

a. Broken spool return spring
b. Broken power piston return spring
c. Loose power steering pump belt

_____7. While servicing a late-model vehicle with an electrically driven hydraulic power-assist unit, you find that the pump cycles while holding steady brake application and that there is fluid backflow from the reservoir port. Which of the following is the *most likely* cause and corrective action?

a. High pump pressure; replace pressure switch
b. Faulty power piston operation; replace piston
c. Air in system; bleed hydraulic system

______8. While servicing a vehicle equipped with hydraulic power brakes, you discover external leakage at the accumulator welds. Which of the following conditions would this leakage cause?

a. No power assist or hard pedal
b. Failure of accumulator test; accumulator does not hold pressure
c. Brake pedal goes to the floor

______9. While servicing a vehicle equipped with vacuum power brakes, you discover leakage at the reaction diaphragm. Which of the following conditions would this defect cause?

a. Sensitive brakes
b. Pedal fails or is slow to release
c. Hard pedal

______10. You are inspecting a 1987 Cadillac equipped with a Powermaster (electrically driven power-assist unit). You find that low pump pressure is the cause of the pump motor running but not shutting off in 20 seconds. Which of the following would be the proper corrective measure?

a. Check pressure line for obstruction; replace pump and motor if necessary
b. Replace pressure switch
c. Check reservoir port for backflow; replace power piston

______11. A vehicle is equipped with vacuum power brakes. You discover a rusted vacuum piston. Which of the following would be the proper corrective measure?

a. Replace master cylinder
b. Recondition piston bore
c. Lubricate piston or replace power brake unit

______12. The owner of a vehicle with vacuum power brakes complains that the brake pedal stays down after she takes her foot off of it. Which of the following is the *most likely* cause?

a. Rusted or dry vacuum piston
b. Plugged compensator port in power brake unit
c. Improperly adjusted brake pedal free play

_____13. A customer brings in a vehicle equipped with a hydraulic power-assist unit. The customer says that he has to apply a lot of pressure to the brake pedal to bring the car to a stop. Which of the following is the *most likely* cause?

a. Power steering reservoir empty
b. Clogged return line from booster to pump reservoir
c. Internal leakage in accumulator

_____14. When servicing an electrically driven hydraulic power-assist unit, you find that the pump reservoir fluid level does not cycle between half full and nearly empty at the pressure switch limits. Which of the following is the *most likely* cause?

a. Faulty pump
b. Faulty power piston operation
c. Pump reservoir not FULL when accumulator is fully depressurized

_____15. You discover that the spool valve bore is scored and nicked when servicing a vehicle with hydraulic power brakes. Which of the following would be the proper corrective measure?

a. Replace booster assembly
b. Recondition bore
c. Overhaul with new bore kit

ASSIGNMENT ANSWERS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

ASSIGNMENT SHEET 1

1. Possible cause(s): (a) Sticking caliper piston, (b) loose wheel bearings, (c) swollen caliper piston seal, (d) defective brake hose or tubing

   Corrective action(s): (a) Repair or replace caliper assembly, (b) inspect and adjust wheel bearings, (c) repair caliper, flush hydraulic system, and fill with approved brake fluid, (d) replace hose or tube

2. Possible cause(s): (a) Clogged master cylinder tubes or hoses, (b) frozen master cylinder pistons

   Corrective action(s): (a) Replace tubes or hoses as necessary, (b) repair or replace master cylinder

3. Possible cause(s): (a) Poor-quality brake fluid would be most likely cause, but may also be caused by (b) weak brake hoses that expand under pressure or (c) air in system

   Corrective action(s): (a) Flush system and fill with approved brake fluid, (b) replace defective hoses, (c) bleed system

4. Possible cause(s): (a) Sticking wheel cylinder piston, (b) sticking caliper piston

   Corrective action(s): (a) Repair or replace wheel cylinder, (b) repair or replace caliper

5. Possible cause(s): (a) Rough or corroded master cylinder bore, (b) loose wheel bearings

   Corrective action(s): (a) Recondition bore or replace master cylinder, (b) inspect and adjust wheel bearings

6. Possible cause(s): (a) Soft or swollen rubber parts caused by incorrect or contaminated brake fluid, (b) plugged master cylinder compensating ports

   Corrective action(s): (a) Replace all rubber parts; flush hydraulic system and fill with approved brake fluid, (b) repair or replace master cylinder

7. Possible cause(s): (a) Loose wheel bearings, (b) worn wheel bearings, (c) sticking caliper pistons or caliper assembly

   Corrective action(s): (a) Inspect and adjust bearings, (b) clean all parts and housings, inspect for abrasive wear, replace bearings if necessary, (c) overhaul caliper and/or lubricate caliper mounting bolts

8. Possible cause(s): (a) Overheating, (b) lubricant failure, (c) overload (wagon)

   Corrective action(s): (a) Replace bearings, check seals, (b,c) check for proper lubrication

9. Possible cause(s): (a) Contamination, (b) lubricant failure

   Corrective action(s): (a) Clean related parts and housing, (b) check seals and replace bearings

10. Possible cause(s): (a) Improper fit, (b) cocking, (c) poor bearing seats

    Corrective action(s): (a) Replace bearing, (b,c) correct bearing seats

11. Possible cause(s): Inadequate lubrication

    Corrective action(s): Replace bearing, clean related parts, check seals, check for proper lubrication

ASSIGNMENT SHEET 2

1. c
2. b
3. c
4. a
5. c
6. a
7. b
8. b
9. a
10. a
11. c
12. b
13. a
14. c
15. a

ACTIVITY SHEETS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

ACTIVITY SHEET 1

Answer general questions about brake hydraulic system and wheel bearings

Name ______________________________

INTRODUCTION

To become certified as a brakes specialist, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence (ASE). The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only brake hydraulic system and wheel bearings, but contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is *most* correct, and write its letter in the answer blank.

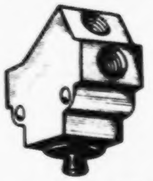
After you have completed this activity sheet, get together with a group of your classmates and use the answer key provided by your instructor to check your answers. Each correct answer counts 4 points for a total score of 100 percent. Pay particular attention to those questions that you answered incorrectly. Do your incorrect answers indicate an area of weakness? Were your incorrect answers caused by carelessness or lack of knowledge? What steps must you take to improve your percentage of correct answers?

Discuss your answers with your group and with the class as a whole.

_____1. Some automobiles with front disc brakes use a metering valve. When bleeding this type of brake with a pressure tank, which of the following apply?

a. The metering valve plunger must be pushed to the closed position
b. The metering valve has no effect on bleeding brakes if a dual master cylinder is used
c. The metering valve plunger must be held open
d. Both a and b

_____2. What brake system valve is pictured below?



a. Pressure differential valve
b. Metering valve
c. Proportioning valve
d. None of the above

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 8, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____3. Swollen cups in the master cylinder could indicate:

a. Solvent contamination
b. Denatured-alcohol contamination
c. Water contamination
d. Both a and c

_____4. The outer bearing race (cup) is spinning (turning) in the front hub. The customer should be sold:

a. A new cup and bearing
b. A new cup only
c. A new hub only
d. A new cup, bearing, and hub

_____5. What quick method can be used to prove that the compensating port in the master cylinder is open?

a. Check free pedal measurement
b. Remove filler cap, press on brake pedal, and observe fluid geyser
c. Bleed wheel cylinder closest to master cylinder and observe fluid geyser
d. Both b and c

_____6. A firm, steady pressure on the brake pedal results in the pedal slowly sinking to the floor. No external leaks can be detected. What is the *most likely* cause?

a. Leaking secondary cup
b. Defective residual check valve
c. Plugged inlet port
d. Leaking primary cup

_____7. When bleeding the brakes, you would normally start with the caliper:

a. Closest to master cylinder
b. Farthest from master cylinder
c. On same side as master cylinder
d. On right front side

_____8. Most combination brake systems use a proportioning valve. Its purpose is to:

a. Reduce pressure at the rear brakes
b. Reduce pressure at the front brakes
c. Act as a safety valve with the dual-type master cylinder
d. Act as a cutoff valve in the event of front or rear system failure

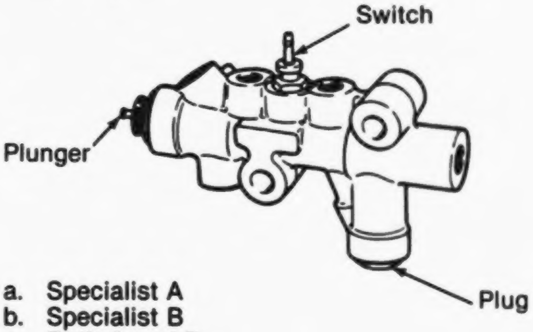
_____9. When replacing a hydraulic brake line, which of the following is the correct procedure?

a. Use seamless copper tubing with single-flared ends
b. Cut out bad section, install copper tubing using a union
c. Use single-length double-flared steel or copper tubing
d. None of the above

_____10. Specialist A says that the valve assembly below actuates the brake warning lamp.

Specialist B says that the valve assembly below delays pressure buildup to the front brakes.

Who is right?



a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 19, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

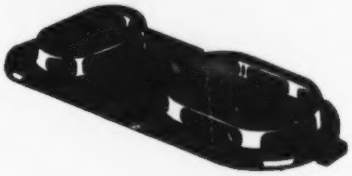
______11. Specialist A says that master cylinders used on disc/drum brake systems have a smaller reservoir for the front disc brakes than they do for the rear drum brakes.

Specialist B says that the disc brake rotors in a disc/drum system require less hydraulic pressure than the rear drums.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

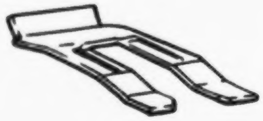
______12. Many brake systems use the rubber diaphragm pictured below. What is its function?



a. Eliminating the need for a residual check valve
b. Maintaining static pressure
c. Preventing water and dirt contamination
d. Allowing for brake pedal "pump-up" if pedal is low

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 21, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

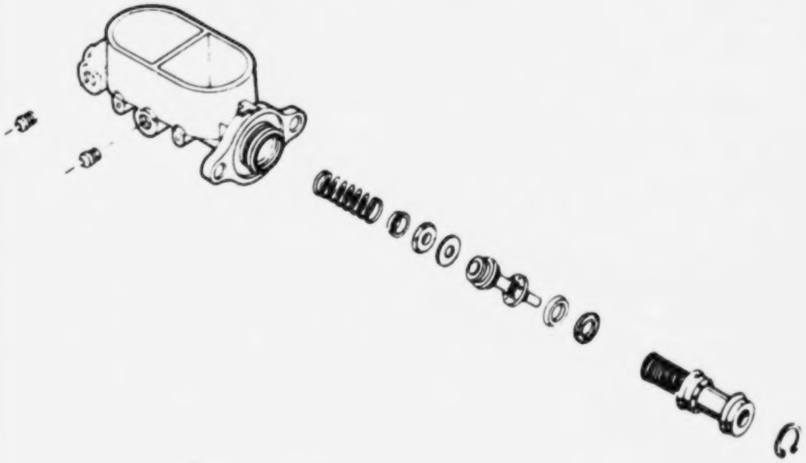
______13. Identify the item illustrated below.



a. Disc brake stabilizer plate
b. Caliper retaining clip
c. Brake hose lock
d. Brake cable equalizer clip

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 23, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

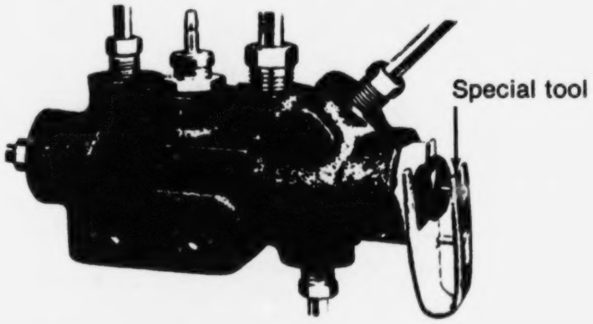
_____14. Refer to the illustration of the master cylinder below. Which part is not in the correct position?



a. Primary piston
b. Secondary piston
c. Primary seal
d. Tube seat inserts

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 27, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____15. The special tool illustrated below is used to:



a. Reset the brake warning valve
b. Hold the metering valve open
c. Test the proportioning valve
d. Check the bypass valve

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 32, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____16. A vehicle equipped with power brakes is losing an excessive amount of brake fluid. There is no sign of external leakage. What would be the first thing to do?

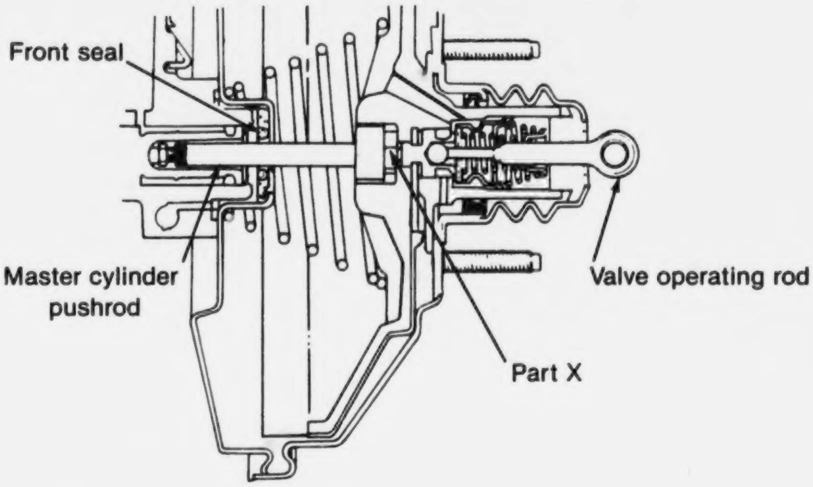
a. Remove power-assist vacuum valve and check inside
b. Remove check valve and measure vacuum
c. Check compensating port clearance
d. Check brake pedal for free play

_____17. A specialist is replacing a master cylinder. The pushrod (see illustration below) is accidentally pulled out and part X falls into the bottom of the power-assist unit.

Specialist A says that this can cause excessive pedal travel.

Specialist B says that this can cause extreme pedal sensitivity.

Who is right?



a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 36, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

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_____18. You are replacing an outside left front wheel bearing that has failed (for the third time in a month). What could be the possible cause?

a. Incompatible grease
b. A worn cup
c. Either a or b
d. Neither a nor b

_____19. An automobile is equipped with a disc/drum system. The rear wheels skid prematurely under hard brake application. Which of the following is the *most likely* cause?

a. Plugged compensating port
b. Defective proportioning valve
c. Defective power-assist unit
d. Trapped air in hydraulic system

_____20. All of the following could cause the brake lights on an automobile not to work EXCEPT:

a. Bad ground at sockets
b. Bad flasher
c. Bad directional switch
d. Bad wiring

_____21. A customer brings in an automobile and relates that the warning light on the dash is on. You examine the circuit and find that it is activated by a switch without centering springs. Which of the following must you do in order to open the circuit and center the terminal in the switch?

a. Remove the switch terminal from the switch body
b. Bleed the system
c. Nothing, as the terminal will automatically center itself
d. Pump the brake pedal

_____22. The stop lights on a customer's vehicle are on all the time. Which of the following is a possible cause?

a. Low fluid level
b. Binding brake pedal
c. Open circuit
d. Ignition on

_____23. The brake warning light on a late-model vehicle comes on at moderate to heavy pedal effort, but goes out when the pedal is released. Which of the following may be the cause?

a. Air in system
b. Malfunctioning switch
c. Master cylinder leak
d. Low tire pressure

_____24. Before replacing mechanical switch, make sure that it is properly adjusted so that circuit closes when brake pedal is depressed approximately

a. ¼ inch
b. ½ inch
c. ¾ inch
d. 1 inch

_____25. In brake operation, the metering valve is used to

a. Delay front brake application
b. Proportion rear pressure to front pressure
c. Delay rear brake application
d. Proportion front pressure to rear pressure

ACTIVITY ANSWERS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

ACTIVITY SHEET 1

1. c
2. b
3. a
4. d
5. b
6. d
7. b
8. a
9. d
10. c
11. d
12. c
13. c
14. b
15. b
16. a
17. c
18. c
19. b
20. b
21. b
22. b
23. a
24. b
25. a

JOB SHEET 1

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 8

Inspect, test, and service hydraulic brake lines and hoses

INTRODUCTION

Hydraulic lines and flexible hoses transmit fluid pressure from the master cylinder to the wheel cylinders and calipers. Even partial blockage of the lines restricts the flow of brake fluid and thus reduces the braking effectiveness of the vehicle. The brakes specialist knows the importance of thoroughly and carefully inspecting, testing, and properly servicing brake lines and hoses.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Seat covers
- Approved brake fluid
- Replacement lines and hoses
- String
- Ruler
- Tubing bender
- Replacement copper washers
- Tubing wrench
- Open-end wrench
- Pliers
- Brake bleeding equipment
- Hydraulic lift or jack and jack stands
- Brake system inspection report form

PROCEDURE

For inspecting lines and hoses

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Raise vehicle and support safely

2. Inspect steel lines and their fittings for

    - stains that indicate a very minute loss of fluid;
    - excessive external rusting;
    - indentions or bruises caused by stones and other road objects

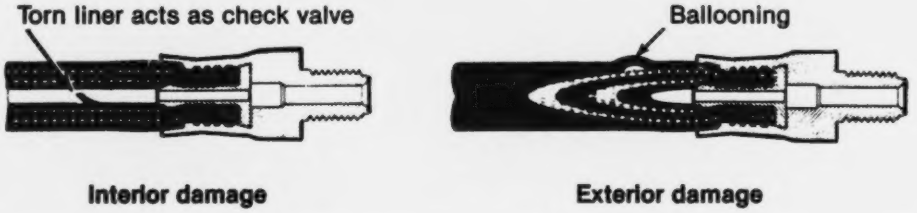
3. Inspect flexible brake hoses for

- chafing caused by stress or unnecessary twist;

  NOTE: Hoses that have functioned under stress will often separate internally. Stress causes the inside lining of the hose to separate and restrict fluid flow, acting as a check valve and possibly producing a dragging brake. See Figure 1 below.

- ballooning caused by separation and rupture of hose layers (See Figure 1);
- cracking, blistering, or fraying near metal fittings

FIGURE 1



From *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Wagner Brake Company, Ltd.

4. Test hoses for internal damage by applying pressure to brake pedal and watching or feeling for any bulging or expansion of hose

5. *If* visual inspection reveals that lines, hoses, and fittings are in good condition, test brake system for line or hose problems that may still exist but may not be evident

   a. Park vehicle on level, unobstructed surface

   b. Protect front seat with seat cover

   c. *If* vehicle is equipped with power-assist unit, place transmission in NEUTRAL or PARK, and start engine

   NOTE: If vehicle has no power-assist unit, perform this test with the engine off.

   d. Firmly depress brake pedal; *if* pedal is spongy or *if* it suddenly sinks to floorboard, the hydraulic system needs repair

6. *If* inspection reveals defective lines, hoses, or fittings, the faulty parts must be replaced

   NOTE: After you have carefully inspected and tested the brake lines and hoses and have determined that a part of a line must be replaced, chances are that other sections of that hydraulic line are also defective. Brake safety experts and vehicle manufacturers strongly recommend that the brakes specialist replace the *entire* line, not just a section of it. Further, it is recommended that the specialist purchase ready-made steel lines whenever possible.

PROCEDURE.

For replacing brake lines

1. Raise vehicle and support safely
2. Study configuration of original line
3. Clean all dirt from ends of tubing and from area around connections to avoid getting dirt into hydraulic system during reassembly
4. Loosen fittings with correct-size tubing wrench or open-end wrench
5. Disconnect line, and allow fluid to drain into container if necessary

   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

6. Properly plug open female connections

   NOTE: Lines have male connections on both ends.

7. Remove old brake tubing, cutting it into smaller pieces as necessary
8. Lay out tubing on floor, and use a string to determine the total length of the entire line
9. Select ISO or double flare replacement tubing of the correct length and diameter to meet vehicle manufacturer's specifications

   CAUTION

   Never use copper tubing in a hydraulic brake system. It does not have the strength of steel tubing and can rupture under high brake pressure.

10. Use tubing bender to shape tubing to configuration of original line, taking care to avoid kinks and sharp bends

11. Carefully blow out tubing with compressed air to remove any foreign matter

12. Install new brake line on vehicle, using proper-size tubing wrench and tightening connections to manufacturer's specifications

PROCEDURE

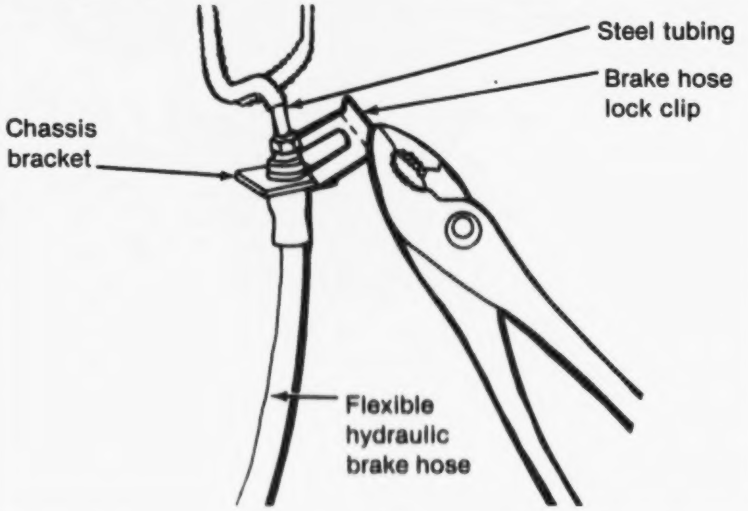
For replacing brake hoses

1. Raise vehicle and support safely

2. Clean all dirt from ends of hose to reduce the possibility of getting dirt in the system during reassembly

3. Loosen jam nut, and disconnect female end of hose first, using pliers to remove lock clip (Figure 2)

FIGURE 2



4. Unscrew male end of hose

5. Measure hose and examine fitting

6. Select replacement hose with same end fittings and of same length of original (or slightly longer than original)

CAUTION

Use only hoses that meet safety standards as specified in vehicle service manual.

NOTE: Hose must be long enough to avoid tension or strain when the suspension springs are in the full-rebound position.

7. Screw a spare tube nut into the female fitting to avoid distortion

8. Place new copper washer over male end of replacement hose, and connect male end first, tightening it to manufacturer's specifications

9. Remove spare tube nut from female fitting

10. Install female end of hose in position that turns curve of hose away from any point of chafing contact; tighten to manufacturer's specifications

11. Install hose suspension spring or support if applicable

12. Check for interference of hose with chassis, suspension, and body during chassis spring rebound and when wheels are steered to extreme left and right

13. Eliminate any interference by loosening female end of hose, repositioning it, and retightening it to manufacturer's specifications

CAUTION

Never twist a brake hose by tightening the male end after the female end has been installed. To avoid twisting the brake hose, hold the hose securely while installing it, and keep the reference line on the hose straight.

PROCEDURE

For completing service

1. Flush hydraulic system to remove air and contaminated fluid

2. Repeat inspection procedures to ensure that there are no leaks in system

3. Lower vehicle to floor

4. Road test vehicle

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

5. Clean work area and return equipment and materials to proper storage

JOB SHEET 2

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 9

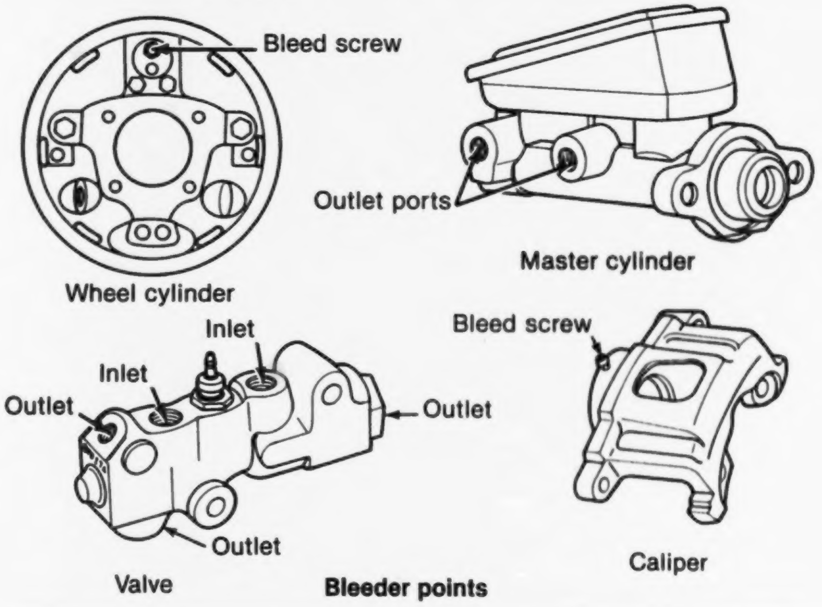
Bleed or flush a hydraulic braking system

INTRODUCTION

The brake hydraulic system must be free of air and contaminants to function properly. Air and contaminants may enter the system when any of the hydraulic parts are disconnected, or when the brakes are operated with the master cylinder fluid level very low. Any air in the system is compressed when pressure is applied, and the results are a springy, spongy brake pedal and ineffective braking action.

Depending on the point at which the hydraulic system was opened, bleeding may be required at all four wheels and the master cylinder, or bleeding may be required at only one location. If the system contains contaminated brake fluid or the wrong type of brake fluid, all old fluid must be flushed from the system and replaced with new. Use the following guidelines and the typical bleeder points illustrated in Figure 1 to aid you in knowing when and where to bleed the hydraulic braking system.

FIGURE 1



Bleeder points

Used with permission of Allied Aftermarket.

- Bleed complete hydraulic system at all four wheels and master cylinder if lines were disconnected from master cylinder or if brakes were operated when master cylinder fluid level was low.

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- Considering whether braking system is a front-to-rear split system or a diagonally split system, bleed hydraulic system at both wheels of affected system circuit if line serving set of wheels was disconnected at master cylinder or if brakes were used when master cylinder fluid level was low in reservoir serving that set of wheels.

- When bleeding brake system, always start at bleeder points farthest away from master cylinder.

- Flush entire system if brake fluid is contaminated or is the wrong type.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Transparent container
- Bleeder hoses (rubber or plastic tubing)
- Approved brake fluid
- Hydraulic lift or jack and jack stands
- Pressure bleeder and reservoir adapter
- Shop cloths
- Fender and seat covers
- Six-point box wrench or brake bleeder wrench
- Metering valve tool

PROCEDURE

For manually bleeding hydraulic system

NOTE: Follow vehicle manufacturer's instructions for bleeding a vehicle with a quick take-up master cylinder or a hydraulic power-assist unit.

1. Remove switch terminal plug from brake warning light switch if applicable

   NOTE: On some American Motors, International Harvester, and Kaiser-Jeep vehicles, the switch terminal will be damaged if the terminal plug is **not** removed before bleeding. Refer to the service manual.

2. Cover fenders and seats

3. Fill master cylinder reservoirs to three-quarters full with clean, approved brake fluid; replace diaphragm and cover

   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

   NOTE: Check the master cylinder fluid level often during the bleeding process. Be sure to keep the reservoirs at least half full to prevent air from entering the system, and make sure that the cover and diaphragm are in position before the brakes are applied.

4. Raise vehicle and support safely

5. Place six-point box wrench or brake bleeder wrench over bleeder screw recommended as first in sequence by service manual

6. Fit tubing snugly over bleeder screw, and submerge free end of tubing in brake fluid in transparent container

7. Apply (or have helper apply) steady pressure on brake pedal

8. Open bleeder screw until fluid flows freely

   NOTE: The bleeder screw may have to be removed and cleaned before fluid will flow. *If* such is the case, plug the opening during the cleaning process.

9. When bleeder screw is opened, the brake pedal will move toward the floorboard; have helper depress pedal all the way

   CAUTION

   Advise your helper **not** to work the brake pedal on and off or to apply great force. Internal damage to the master cylinder may result.

10. Close bleeder screw and instruct helper to release brake pedal

11. Repeat steps 7 through 10 until fluid is completely free of air bubbles

12. Remove tubing and brake bleeder wrench

13. Check master cylinder reservoirs, and refill with clean, approved brake fluid to at least three-quarters full if necessary

14. Repeat bleeding procedure for other bleeding locations as recommended by service manual

15. Check brake pedal to be sure that it is high and firm; *if* it feels spongy, repeat manual bleeding procedure

16. Reinstall brake warning light switch terminal plug

17. Center pressure differential valve if necessary

    NOTE: Bleeding the front brakes creates an imbalance in the hydraulic pressure between the front and rear braking systems. This pressure difference will cause the brake warning light to come on. Centering the pressure differential valve equalizes the pressure and turns off the brake warning light.

    a. With transmission in PARK or NEUTRAL and engine running, depress brake pedal

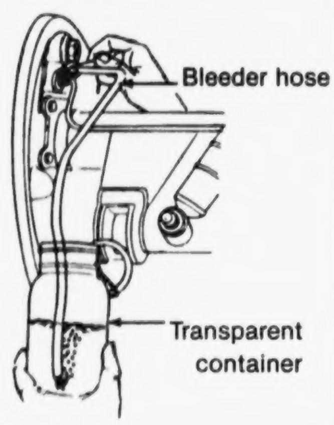
       NOTE: The pressure differential valve piston should center itself, turning off the brake warning light. *If* the light remains on, the switch is not self-centering, and you must relieve pressure in the rear braking system by performing the following steps.

    b. Remove switch terminal plug from brake warning light switch

    c. Have helper hold brake pedal firmly at floorboard

    d. Install brake bleeder wrench and tubing over either rear wheel cylinder bleeder screw, and submerge free end of tubing in brake fluid as shown in Figure 2

FIGURE 2



Used with permission of Allied Aftermarket.

   e. Quickly open and close bleeder screw

   f. Reinstall brake warning light switch terminal plug

18. Lower vehicle to floor

19. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

20. Clean work area and return equipment and materials to proper storage

PROCEDURE

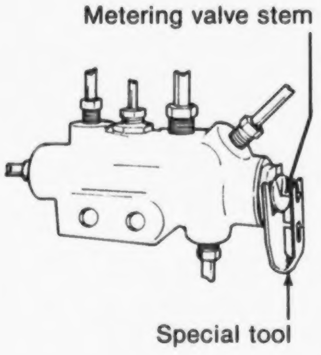
For pressure bleeding hydraulic system

NOTE: Follow vehicle manufacturer's instructions for bleeding vehicles with a quick take-up master cylinder, or hydraulic power-assist unit.

1. Perform steps 1 through 3 under manual bleeding procedure

2. *If* vehicle's brake system is equipped with a metering valve (part of the combination valve), attach metering valve tool to hold valve open as shown in Figure 3

FIGURE 3



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3. Check pressure bleeder tank to be sure that there is enough brake fluid to complete bleeding operation; fill if necessary

4. Charge tank to pressure specified by pressure bleeder manufacturer

5. Attach appropriate reservoir adapter to master cylinder, consulting service manual for installation procedures

   NOTE: Different vehicles require different sizes and types of bleeder adapters, and the methods of attaching these adapters will vary.

6. Open valve in pressure bleeder hose to pressurize tank

7. Raise vehicle carefully and support safely, taking care **not** to damage bleeding equipment

8. Place six-point box wrench or brake bleeder wrench over bleeder screw recommended as first in sequence by service manual

9. Fit tubing snugly over bleeder screw, and submerge free end of tubing in brake fluid in transparent container

10. Open bleeder screw until fluid flows freely

    NOTE: The bleeder screw may have to be removed and cleaned before fluid will flow. *If* such is the case, plug the opening during the cleaning process.

11. When fluid coming from end of submerged tubing is completely free of air bubbles, close bleeder screw securely and remove wrench

12. Repeat steps 8 through 11 for other bleeding locations as recommended in service manual

13. Check master cylinder fluid level, and refill with clean, approved brake fluid to at least three-quarters full if necessary

    CAUTION

    Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

14. Check brake pedal to be sure that it is high and firm; *if* it feels spongy, repeat pressure bleeding procedure

15. Reinstall brake warning light switch terminal plug

16. Center pressure differential valve if necessary, following instructions under step 17 of manual bleeding procedure

17. Lower vehicle to floor

18. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

19. Clean work area and return equipment and materials to proper storage

PROCEDURE

For surge bleeding hydraulic system

NOTE: *If* manual or pressure bleeding procedures failed to remove all air from the system, the system should be surge bled. Surge bleeding includes both manual and pressure bleeding and deliberately creates a churning, higher pressure turbulence so that any trapped air can be drawn off. It is important to remove all possible air before surging, thus this method is **never** used unless manual or pressure bleeding has proved inadequate.

1. Pressure bleed or manually bleed hydraulic system at all four wheels in the usual manner

2. Have helper depress brake pedal sharply several times while you open and close bleeder screw at each wheel cylinder in turn

   NOTE: This action creates turbulence in each cylinder, forcing out trapped air.

3. Check master cylinder fluid level; refill with approved, clean brake fluid to three-quarters full if necessary

   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

4. Check brake pedal to be sure that it is high and firm; *if* it feels spongy, repeat surging procedure

5. Reinstall brake warning light switch terminal plug

6. Center pressure differential valve if necessary, following instructions under step 17 of manual bleeding procedure

7. Lower vehicle to floor

8. Road test vehicle

   ► WARNING ◄

   Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

9. Clean work area and return equipment and materials to proper storage

JOB SHEET 3

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 17

Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals

INTRODUCTION

Dirt is the most common cause of wheel bearing failure. Most vehicle manufacturers recommend that bearings be serviced and lubricated at intervals of 25,000 to 30,000 miles.

EQUIPMENT AND MATERIALS

- Vehicle
- Wheel cover removing tool
- C-clamp
- Hydraulic lift or jack and jack stands
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Fender and seat covers
- Syringe
- Low-pressure air nozzle
- Dust cap removing tool
- Seal driver
- Dial indicator
- Torque wrench
- Appropriate service manual
- Wooden dowel
- Wheel bearing packer
- Clean shop towels
- Parts-cleaning brush
- Wood blocks
- Appropriate wheel bearing grease
- Approved cleaning solvent
- Approved brake fluid
- Replacement grease seals
- Diagonal pliers
- Small chain or wire
- Chalk or marker
- Rubber-tipped hammer
- Screwdriver or brake adjusting spoon
- Open-end wrench
- Replacement parts as necessary
- Brake system inspection report form

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Cover fenders and seats

2. Use syringe to remove about two-thirds of brake fluid from master cylinder reservoir supplying front or rear wheels, depending on bearings to be serviced

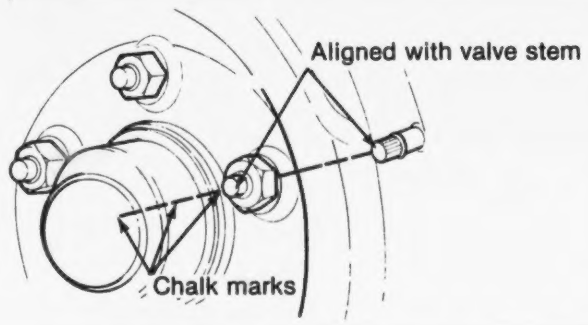
   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do **not** allow fluid to get into eyes. Keep brake fluid away from fire; brake fluid is flammable.

3. Raise vehicle and support safely

4. To ensure that balanced wheels are reinstalled in same position, mark with chalk or marker each wheel to be removed as shown in Figure 1

FIGURE 1



From *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Ford Motor Company.

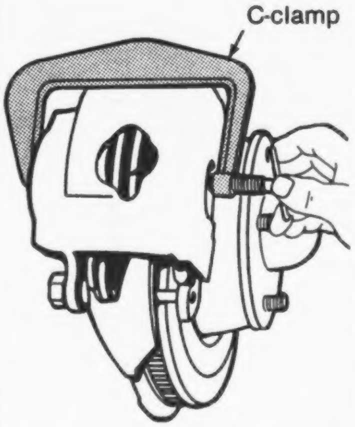
5. Remove front or rear wheels, depending on bearings to be serviced

PROCEDURE

For removing front disc brake bearing assemblies

1. Use C-clamp to compress each caliper piston to bottom of its bore (Figure 2)

FIGURE 2



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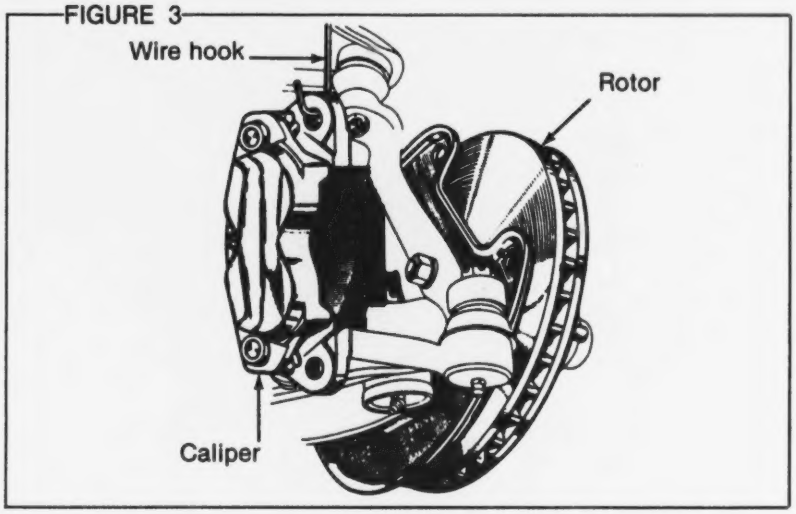
2. Remove each front caliper from its position over rotor, and hang from frame or suspension member with chain or wire as shown in Figure 3 below

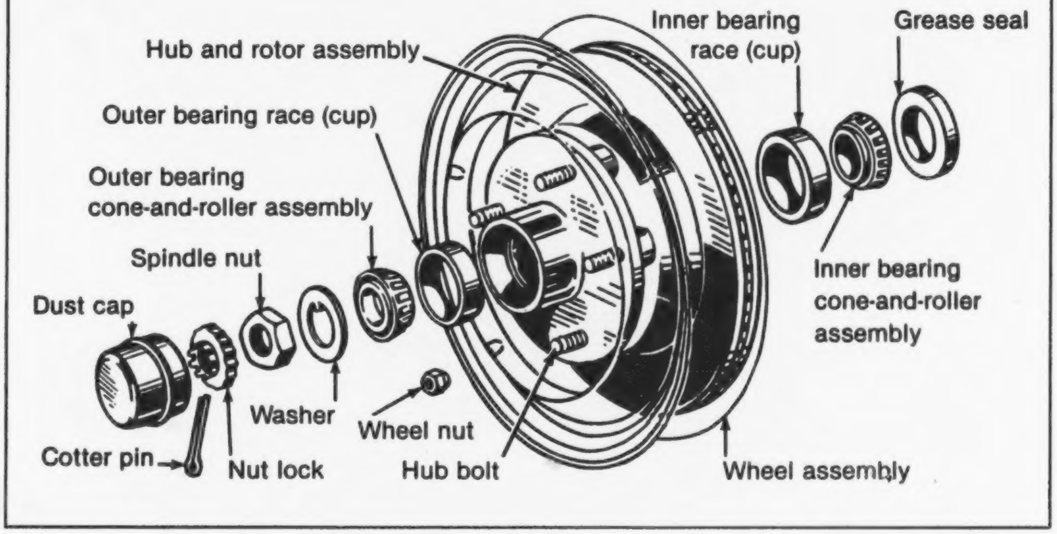
FIGURE 3


Wire hook
Rotor
Caliper

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

3. Remove hub and rotor assemblies (Figure 4)

FIGURE 4


Hub and rotor assembly
Inner bearing race (cup)
Grease seal
Outer bearing race (cup)
Outer bearing cone-and-roller assembly
Spindle nut
Dust cap
Inner bearing cone-and-roller assembly
Washer
Wheel nut
Cotter pin
Nut lock
Hub bolt
Wheel assembly

From *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Ford Motor Company.

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a. Remove dust cap with dust cap removing tool

NOTE: *If* dust cap removing tool is not available, the dust cap can be carefully removed with channel-lock pliers.

CAUTION

Whichever tool you use, avoid damaging the dust cap. If bent, the cap may not seal properly, allowing moisture and dirt to enter the hub and damage the bearings.

b. Using diagonal pliers, straighten ends of cotter pin, pry it out of hole in spindle, and discard pin

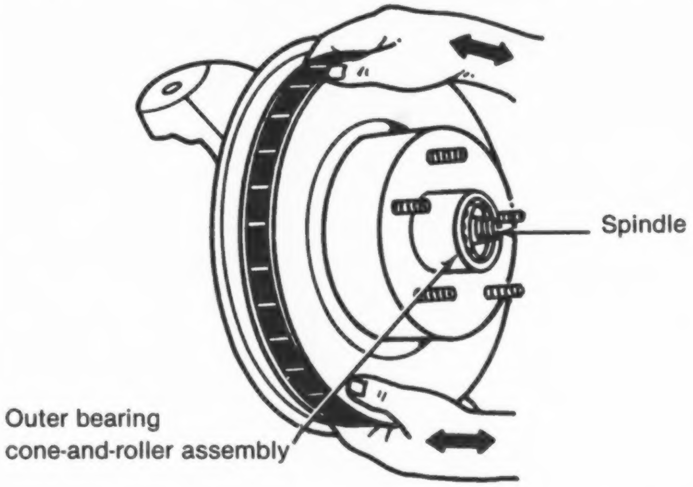
c. Use your fingers to remove nut lock if vehicle is so equipped

d. Remove spindle nut with open-end wrench

e. Remove washer from spindle, and then slide outer bearing cone-and-roller assembly off spindle

NOTE: You may have to rock the rotor back and forth as shown in Figure 5. Rocking the rotor slides the outer cone-and-roller assembly out on the spindle to a position that enables you to grasp it with your fingers.

FIGURE 5



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CAUTION

Always keep the cone-and-roller assemblies in the correct position for the rotor from which you remove them. Because each assembly sets up a wear pattern in its race, the assembly and race are a matched set. Keep each set with its own pieces; do not mix them, and do not reinstall them on the opposite spindle.

f. Place outer cone-and-roller assembly on a clean cloth or a piece of paper

g. Grasp rotor with both hands and pull it off spindle, taking care **not** to scrape rotor against spindle, as this could damage spindle threads

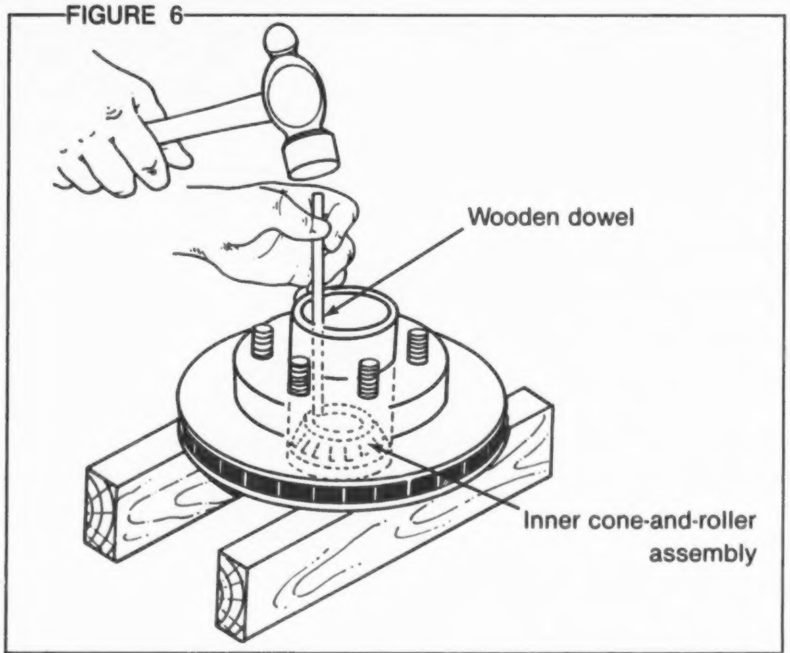
h. Place rotor on a clean area of your workbench, with outside of rotor facing up

i. Repeat procedure for other front disc brake rotor

j. Remove inner wheel bearing cone-and-roller assemblies and grease seals from rotors

    (1) Raise rotor on wood blocks as shown in Figure 6

FIGURE 6



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(2) Remove inner cone-and-roller assembly from hub by gently tapping wooden dowel with hammer while moving dowel around edge of inner cone until grease seal and inner cone-and-roller assembly fall out

(3) Remove inner cone-and-roller assembly and grease seal from other disc brake rotor assembly

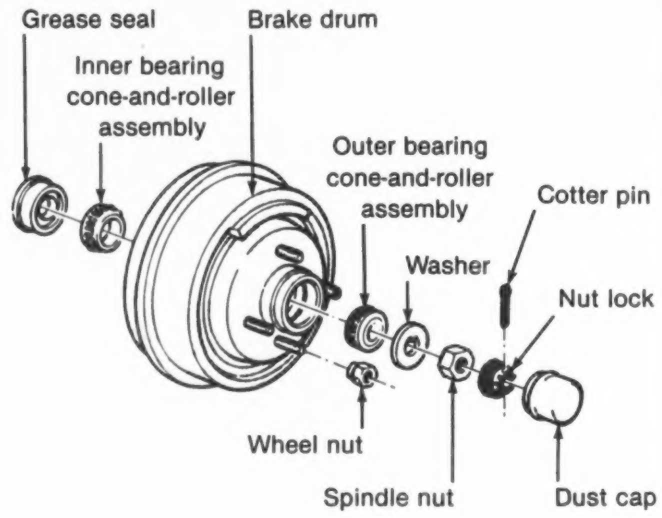
PROCEDURE

For removing drum brake bearing assemblies (front-wheel drive)

1. Release parking brake from inside vehicle
2. Loosen parking brake cable as required by backing off adjusting nut at equalizer
3. *If* more clearance is needed, remove plug from support plate and rotate star wheel with an upward motion, using screwdriver or brake adjusting spoon
4. Remove drum assembly (Figure 7)

NOTE: The procedure for removing drum brake assemblies on vehicles with rear-wheel drive may vary slightly. Consult your service manual.

FIGURE 7


Grease seal
Brake drum
Inner bearing cone-and-roller assembly
Outer bearing cone-and-roller assembly
Cotter pin
Washer
Nut lock
Wheel nut
Spindle nut
Dust cap

Used with permission of Chrysler Corporation.

a. Remove dust cap with dust cap removing tool

   NOTE: *If* a dust cap removing tool is not available, the dust cap can be carefully removed with channel-lock pliers.

   CAUTION

   Whichever tool you use, avoid damaging the dust cap. If bent, the cap may not seal properly, allowing moisture and dirt to enter the hub and damage the bearings.

b. Straighten end of cotter pin with diagonal pliers, pry it out of hole in spindle, and discard

c. Use your fingers to remove nut lock

d. Remove spindle nut with open-end wrench

e. Remove washer from spindle, and then slide outer bearing cone-and-roller assembly off spindle

   NOTE: You may have to rock the brake drum back and forth to slide the outer bearing assembly to a position that enables you to grasp it with your fingers.

   CAUTION

   Always keep the bearing assemblies in the correct position for the drum from which you remove them. Because each assembly sets up a wear pattern in its race, the assembly and race are a matched set. Keep each set with its own pieces; do **not** mix them, and do **not** reinstall them on the opposite spindle.

f. Place outer bearing assembly on a clean cloth or piece of paper

g. Grasp drum with both hands and carefully pull it off spindle, taking care **not** to scrape drum against spindle, as this could damage threads on end of spindle

h. Place drum on a clean area of your workbench, with inside of drum facing up

i. Repeat procedure for other drum brake

j. Remove inner wheel bearing assembly and grease seals from drums

   (1) Raise drum on wooden blocks as shown in Figure 6 for disc brakes

(2) Remove inner bearing assembly and grease seal from drum by gently tapping wooden dowel with hammer while moving dowel around edge of cone until bearing assembly and seal fall out

(3) Repeat procedure for other brake drum

PROCEDURE

For cleaning and inspecting bearing assemblies

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Use a rag to wipe excess grease off each bearing assembly
2. Soak each assembly in cleaning solvent, taking care **not** to mingle right and left sets

► WARNING ◄

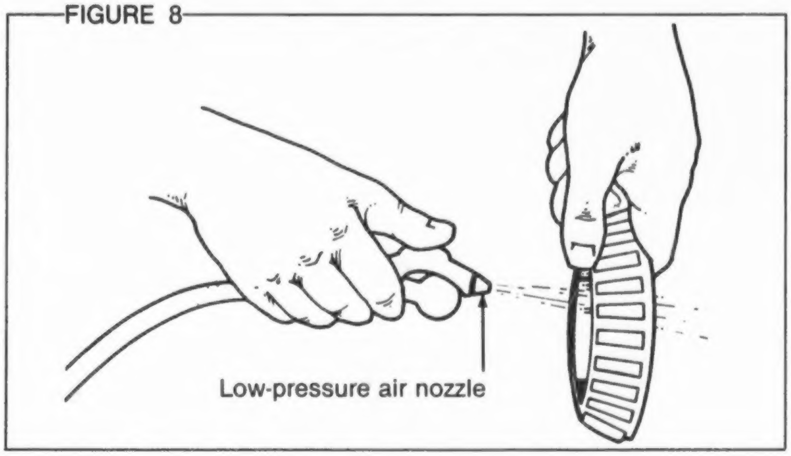
Always use solvent recommended by vehicle manufacturer. **Never** use gasoline or any other volatile liquid as a cleaning solvent. Such liquids are fire hazards and can be harmful to the skin and eyes.

3. After they have soaked, scrub each assembly with parts-cleaning brush until assembly is clean
4. Using low-pressure nozzle, blow out any remaining dirt particles and solvent from each assembly (Figure 8)

CAUTION

Do **not** spin the rollers with compressed air. Spinning may damage the rollers or the inside race, or cause the assembly to fly apart with violent force.

FIGURE 8



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5. Using a rag and cleaning solvent, carefully clean grease and dirt from hub, races, and spindle so that they will **not** contaminate the clean bearing assemblies when they are installed later

6. Visually inspect each bearing assembly for the following defects (Refer to Student Supplement 5 as necessary)

    - Cage damage or wear
    - Roller wear
    - Frettage
    - Brinnelling
    - Etching
    - Indentations
    - Fatigue spalling
    - Galling

7. Place each cone-and-roller assembly into its original position in hub, and using your fingers, turn inner race to test each assembly in turn for roughness

8. *If* you detect roughness, rinse and dry assembly again, and repeat rotation test with your fingers

9. *If* you still detect roughness, replace defective wheel bearing assembly

10. Wrap cone-and-roller assemblies in a clean shop towel or in paper to protect them from dust and dirt

11. Visually inspect each bearing race for the following defects while it is still seated in the hub

    - Hairline cracks
    - Pits or indentations
    - Heavy wear patterns
    - Hard spots (slightly flatter and very shiny areas)
    - Dark bluish heat discoloration
    - Light brown to black stain discoloration

12. *If* race is in good condition, coat it with a thin layer of wheel bearing grease and leave it in place; *if* it is defective, replace bearings and races as sets

PROCEDURE

For repacking bearing assembly with bearing packer

NOTE: Even new bearing assemblies must be packed. Be sure to repack the assemblies with *only* the wheel bearing grease specified by the vehicle manufacturer. Read the container label or check the manufacturer's specified lubricant to be sure that you are using the proper grease.

1. Install bearing packer on bearing assembly, following packer manufacturer's directions

2. Use packer to apply grease until all assembly cavities are filled

3. Remove assembly from packer, and apply a coat of grease to inner and outer edges of bearing cage

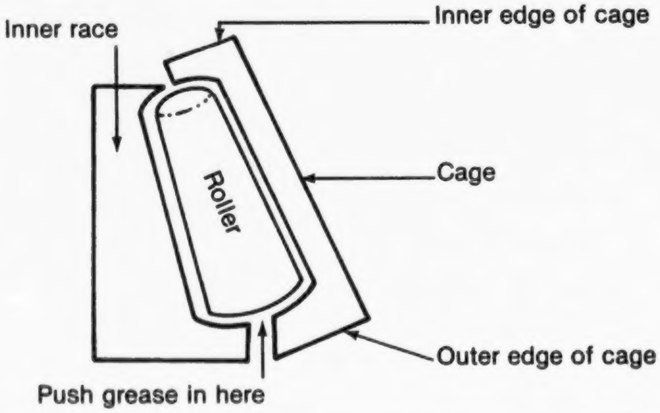
4. Wrap packed assembly in a clean cloth or paper towel to protect fresh grease from dirt and dust; repeat packing procedure on each of other assemblies

PROCEDURE

For repacking bearing assembly by hand

1. Thoroughly work grease into bearing cage until **all** spaces between cage and rollers are filled, as shown in Figure 9

FIGURE 9



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2. With your fingers, apply a thin coat of grease to inner and outer edges of cage

3. Wrap packed assembly in a clean cloth or paper towel to protect fresh grease from dirt and dust; repeat packing procedure on each of other assemblies

PROCEDURE

For reinstalling packed cone-and-roller assemblies and grease seals

NOTE: After you repack all of the cone-and-roller assemblies and replace any defective parts, you must install the inner cone-and-roller assembly and a new grease seal in each hub.

1. Apply a thin coat of wheel bearing grease to inside of hub and bearing races

2. Place packed inner cone-and-roller assembly into hub, with tapered end facing inward, toward hub recess

CAUTION

Be sure to replace the inner and outer cone-and-roller assemblies in their original positions on the left and right hub.

3. Inspect replacement grease seal for defects; *if* seal is in good condition, spread a thin coat of bearing grease around seal lip (inner surface of seal)

4. Position seal with its lip edge facing inward, toward the cone-and-roller assembly (Figures 10 and 11)

FIGURE 10

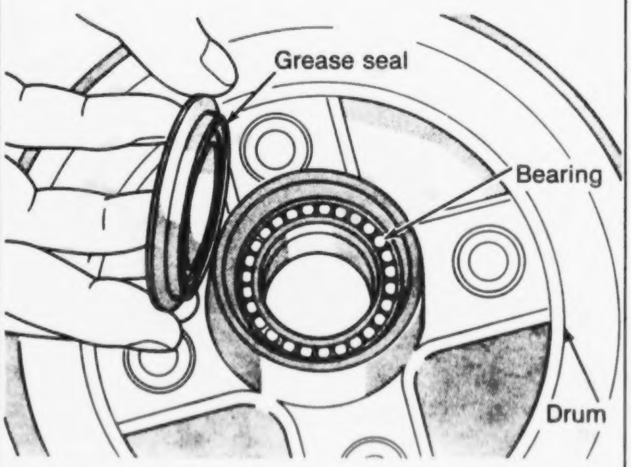

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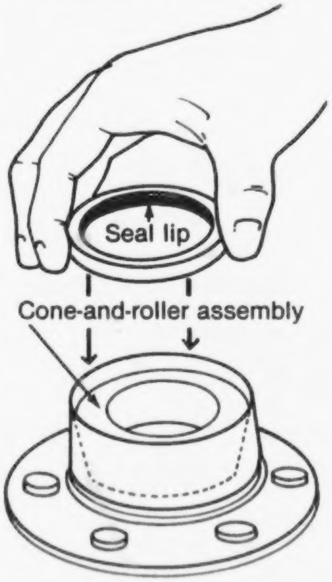
FIGURE 11



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5. Install seal with seal driver, gently tapping driver with rubber-tipped hammer until seal is firmly in place

CAUTION

Always tap gently when performing this procedure. Heavy blows will damage the seal.

6. Repeat procedure for other cone-and-roller assembly

PROCEDURE

For reinstalling brake and wheel assemblies

1. Grasp rotor or drum with both hands, and carefully slide it over spindle, taking care **not** to allow interior of drum or rotor hub to contact and damage threaded end of spindle

   NOTE: As drum or rotor reaches the part of the spindle with the largest diameter, you will feel some resistance. Push the rotor or drum firmly past this point.

2. Insert outer cone-and-roller assembly into hub, with tapered end facing toward center of hub

3. Place washer and then spindle nut on spindle

4. Adjust wheel bearings

   a. Torque spindle nut to manufacturer's specifications while turning wheel assembly forward by hand to seat the bearings

      NOTE: In addition to seating the bearings, turning the wheel assembly by hand removes any grease or burrs that could cause wheel-bearing play later.

   b. Back off spindle nut to "just loose" position

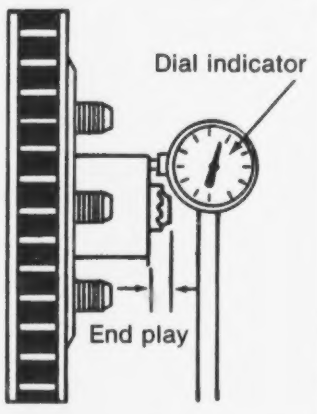
   c. Retorque spindle nut to manufacturer's specifications

      NOTE: Some manufacturers call for finger-tightening the spindle nut at this point rather than using a torque wrench. Follow directions in service manual for vehicle you are working on.

   d. Measure looseness (end play) in hub assembly

      (1) Attach dial indicator as shown in Figure 12 on the following page

FIGURE 12



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    (2) Push drum or rotor assembly in, and line up zero on indicator dial with pointer hand

    (3) Pull hub out and note reading on dial indicator

    (4) Adjust spindle nut until end-play reading is within specifications

  e. Retorque spindle nut to manufacturer's specifications

5. Reinstall nut lock, if applicable, aligning it with cotter pin hole

CAUTION

Never move the spindle nut in order to align the nut lock with the spindle hole. This would make your final adjustment too loose or too tight. Once the spindle nut has been torqued to its final specifications, it is important **not** to move it.

6. Install new cotter pin

CAUTION

Always install a new cotter pin. **Never** reuse an old cotter pin as it has been weakened during removal and is unsafe.

  a. Insert cotter pin through nut lock or castellated nut and through hole in spindle

  b. Bend ends of cotter pin in opposite directions to secure it; cut off extra length to ensure that ends will not interfere with dust cap

7. Reinstall dust cap on hub and perform service on other wheel as necessary
    a. Clean dust cap with solvent
    b. Center dust cap on rotor hub
    c. Use rubber-tipped hammer to tap dust cap onto hub
8. Readjust star wheel and parking brake cable on drum brakes, or reinstall calipers and adjust parking brake cable on disc brakes
9. Reinstall wheel/tire assemblies in their original positions, finger-tightening lug nuts
10. Lower vehicle to floor
11. Torque lug nuts in cross pattern to manufacturer's specifications
12. Install wheel covers
13. Bleed hydraulic system (Procedure Sheet 2)
14. Check master cylinder fluid level, and refill with clean, approved brake fluid to at least three-quarters full if necessary

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable. Keep brake fluid away from fire.

15. Reinstall master cylinder diaphragm and cover and secure with cover bails
16. Road test vehicle

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

17. Clean work area and return equipment and materials to proper storage

JOB SHEET 4

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 18

Adjust wheel bearings

INTRODUCTION

Adjusting the wheel bearings is one of the most important parts of brake service. If wheel bearings are adjusted too tightly or too loosely, they will overheat or wear improperly and become damaged quickly. Loose wheel bearings can also cause rapid tire wear, uneven steering, and vibrations when braking.

Wheel bearings are normally adjusted (1) when they have been removed for routine cleaning, inspection, and repacking (approximately every 24,000 miles), (2) when brake suspension work is being done and the drum or disc brake rotor must be removed as part of the work, and (3) when they do not meet manufacturer's specifications.

Always follow the vehicle manufacturer's specifications when adjusting wheel bearings. Improper adjustment can cause damage to the bearings and tires, as well as poor vehicle handling and braking vibrations.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Dial indicator
- Rubber mallet
- Hydraulic lift or jack and jack stands
- Replacement cotter pins
- Solvent for cleaning dust cap
- Diagonal-cutting pliers
- Hub cap remover
- Dust cap remover
- Eye protection
- Torque wrench

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Raise vehicle and support safely

2. Remove wheel cover

3. Remove dust cap from hub

CAUTION

When removing the left-front dust cap, use care to avoid damage to the speedometer drive connection on some models.

4. Remove cotter pin from spindle and spindle nut

5. Remove nut lock *if* vehicle is so equipped

   NOTE: Most manufacturers today use a nut lock, which is a locking device that makes it possible to reinstall the cotter pin without moving the adjusted spindle nut.

6. Torque spindle nut to manufacturer's specifications while turning wheel assembly forward by hand to seat bearings

   NOTE: In addition to seating the bearings, turning the wheel assembly by hand removes any grease or burrs that could cause wheel bearing play later.

7. Back off spindle nut to "just loose" position

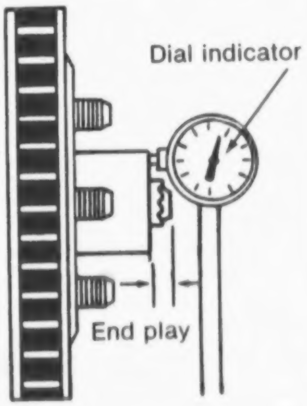
8. Retorque spindle nut to manufacturer's specifications

   NOTE: Some manufacturers call for finger-tightening the spindle nut at this point rather than using a torque wrench. Follow directions in service manual for vehicle you are working on.

9. Measure looseness (end play) in hub assembly

   a. Attach dial indicator as shown in Figure 1

FIGURE 1



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    b. Push drum or rotor assembly in, and line up zero on indicator dial with pointer hand

    c. Pull hub out and note reading on indicator

    d. Adjust spindle nut until end play reading is within specifications

10. Retorque spindle nut to manufacturer's specifications

11. Reinstall nut lock, if applicable, aligning it with cotter pin hole

    CAUTION

    Never move the spindle nut in order to align the nut lock with the spindle hole. This would make your final adjustment too loose or too tight. Once the spindle nut has been torqued to final specifications, it is important **not** to move it.

12. Install new cotter pin

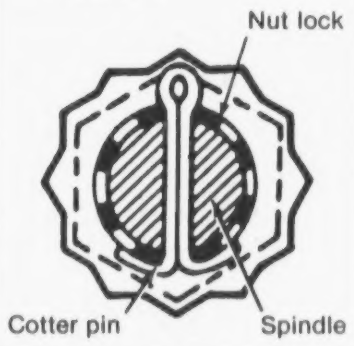
    CAUTION

    Always install a new cotter pin. **Never** reuse an old cotter pin as it has been weakened during removal and is unsafe.

    a. Insert cotter pin through nut lock or castellated nut and through hole in spindle

    b. Bend ends of cotter pin in opposite directions to secure it; cut off extra length to ensure that the ends will not interfere with dust cap (Figure 2)

FIGURE 2



From *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Ford Motor Company.

13. Reinstall dust cap on hub

    a. Clean dust cap with solvent

    b. Center dust cap on rotor hub

    c. Use rubber mallet to tap dust cap onto hub

14. Replace wheel cover, and perform adjustment procedure on other wheels

15. Bleed hydraulic system (Procedure Sheet 2)

16. Lower vehicle to floor

17. Check master cylinder fluid level, and refill with clean, approved brake fluid to at least three-quarters full if necessary

    CAUTION

    Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

18. Reinstall master cylinder cover and diaphragm

19. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

20. Clean work area and return equipment and materials to proper storage

JOB SHEET 5

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 19

Remove and replace front-wheel-drive nonserviceable sealed wheel bearings

INTRODUCTION

When the front-wheel bearings are sealed, nonadjustable units, they require no periodic attention. They are bolted to the steering knuckle by means of an integral flange. Service procedures requiring hub removal, however, may require that a new bearing be installed.

Because removal and installation procedures vary with make and model of vehicle, the brakes specialist should always consult the appropriate service manual for the proper procedure. Certain general precautions and guidelines should be observed, however, and these are listed below.

- Follow all asbestos safety guidelines and use the latest in enclosure equipment for removal and replacement.
- After removal, discard the old hub nut and be sure to use a new nut and a new washer on assembly; do not use the old ones.
- Do not allow the caliper to hang from the brake hose; suspend it with a length of wire.
- If the old bearing is to be reused, match mark the bolts and holes for proper installation.
- If corrosion is present, make sure that the bearing is loose in the knuckle before pulling it out.
- Clean mating surfaces of all dirt and corrosion, and check knuckle bore and knuckle seal for damage.
- If a new bearing is to be installed, remove the knuckle seal and install a new one.
- If the rotor and hub start to rotate as the hub nut is tightened on reassembly, insert a long bolt through the cutout in the hub assembly to prevent rotation.
- Do not apply full torque to the hub nut until the wheel has been reinstalled and the vehicle lowered to the floor.
- When reinstalling the caliper, make sure that the caliper hose is not twisted.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 6

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 21

Remove and replace a dual master cylinder

INTRODUCTION

Since 1967, all domestic vehicles have been designed with front and rear brake systems that utilize the dual (double-piston) master cylinder. Safety is the main advantage of the dual system over the single-piston master cylinder. In case of failure in one of the brake systems, the dual master cylinder system enables the system still operating to bring the vehicle to a safe, controlled stop.

Originally master cylinders were made of cast iron and were heavy. However, most master cylinders used in today's vehicles are composite master cylinders. Most use a plastic nylon reservoir in an aluminum housing. Composite master cylinders offer reduced weight and lower materials costs and have a greater application flexibility. Aluminum master cylinders also feature an anodized body to protect against corrosion and to extend bore life.

On the majority of today's vehicles, a power brake booster is attached to or is a part of the master cylinder. Because of this, the procedures for removing and reinstalling a master cylinder vary, and the brakes specialist should always consult the appropriate service manual for the proper procedure. Certain general precautions and guidelines should be observed, however, and these are listed below.

General guidelines

- The two major defects indicating master cylinder replacement are internal seal failure and external leakage caused by a master cylinder with excessive scoring or pitting.
- Leakage at the reservoir cover can often be corrected by replacing the diaphragm and bending the cover bails to fit more securely.
- Leakage at the rear of the master cylinder indicates that the rear primary piston seal is leaking.
- Carefully inspect master cylinder bore for any scoring, pitting, or scratches. Light scoring in a cast-iron master cylinder can be cleaned with crocus cloth or honed. Aluminum master cylinders should not be reconditioned. If the cylinder bore is scored, pitted, or scratched, replace the complete master cylinder assembly.
- Discard and replace all rubber parts.

- Before assembling a master cylinder, dip each of its components in clean brake fluid and place them on a clean shop towel. Assembling a master cylinder with dry seals can ruin them.
- To ensure their sealing qualities, make sure that the cup lips enter the bore evenly.
- Adjust brake pedal free play after master cylinder installation.
- After installation, test to be sure that the master cylinder vents at both ports. Apply the pedal lightly with the engine running and observe the ports to see whether a geyser of fluid squirts up in the reservoirs. A fluid geyser indicates that the vent port is open.
- Bleed the brakes after installation, and check to see that the brake warning light is off. If the warning light is on, the master cylinder may be defective.

Safety guidelines

- Raise vehicle and support safely.
- Know and observe all asbestos safety rules.
- Before road testing the vehicle, make sure that there is adequate fluid in the master cylinder and that the brake pedal is firm and high. Make a series of low-speed stops to be sure that the brakes are safe for road testing.
- Handle brake fluid carefully and do not use near heat or fire. Brake fluid is flammable. Take care also not to spill brake fluid on any painted or chrome surface as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do not allow fluid to get into eyes!

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 7

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

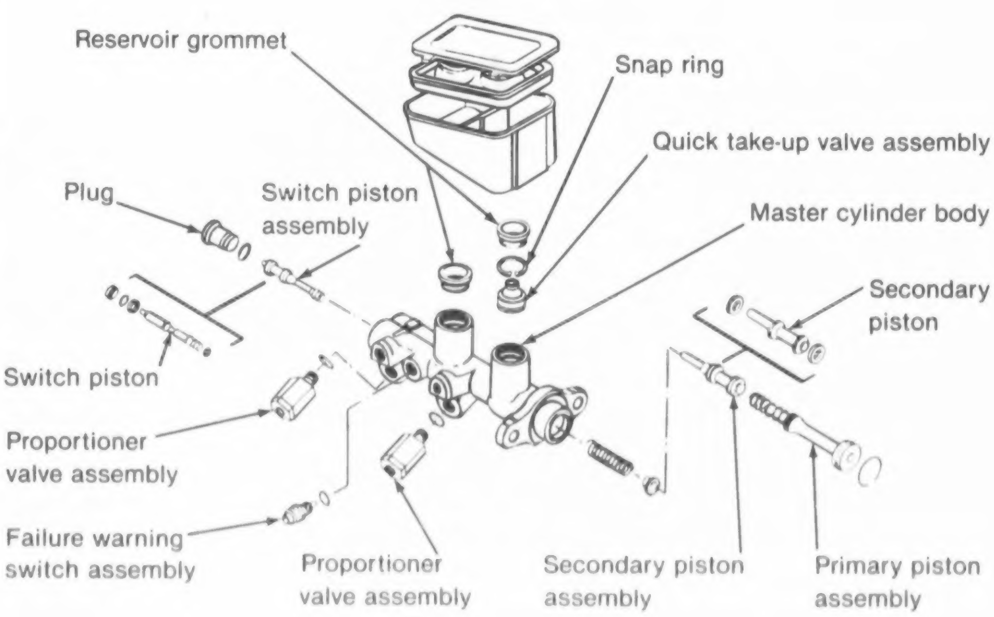
OBJECTIVE 22

Remove and replace a take-up valve in a quick take-up master cylinder

INTRODUCTION

Quick take-up master cylinders may give rise to a problem unique to them. Imagine that you have bled the brakes and have expelled all air from the brake system. The brake shoes and pads are operating correctly, but the brake pedal is still very low. The cause of this problem may very well be a defective take-up valve inside the master cylinder (see Figure 1). This valve can be removed and replaced on many vehicles.

FIGURE 1


Reservoir grommet
Snap ring
Quick take-up valve assembly
Plug
Switch piston assembly
Master cylinder body
Secondary piston
Switch piston
Proportioner valve assembly
Failure warning switch assembly
Proportioner valve assembly
Secondary piston assembly
Primary piston assembly

Used with permission of Allied Aftermarket.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Set of flare-nut or tubing wrenches
- Flat-blade screwdriver
- Socket set
- Pliers

- Rubber-tipped hammer
- Fender and seat covers
- Replacement take-up valve
- Brake fluid
- Snap-ring pliers

PROCEDURE

1. Cover fenders and seats

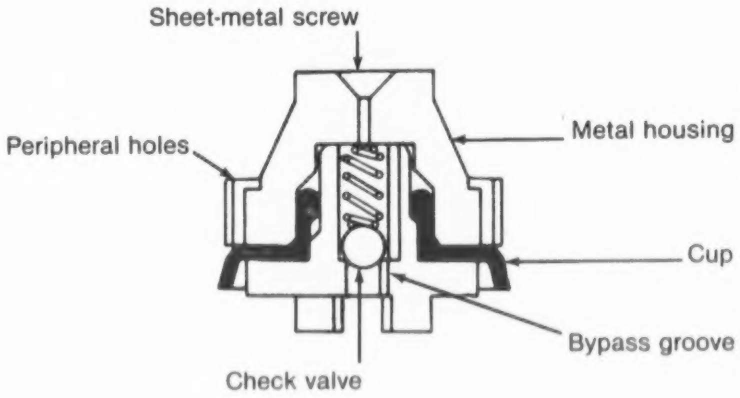
2. Remove reservoir from top of master cylinder and set reservoir aside where it will not get damaged or lost

3. Remove reservoir grommet (See Figure 1)

4. Remove snap ring that retains take-up valve inside metal housing of master cylinder (See Figure 1)

5. Remove sheet-metal screw from valve center, if applicable (Figure 2)

FIGURE 2



Quick take-up valve assembly

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984*.

6. Use pliers to extract valve assembly from metal housing (see Figure 2); discard valve assembly in appropriate receptacle

7. Install replacement take-up valve (See Figure 2)

    a. Position valve assembly on metal housing (See Figure 1)

   b. Place an appropriate-sized socket on top of valve assembly

   c. Install valve in housing by tapping firmly on socket with rubber-tipped hammer

8. Reinstall sheet-metal screw in center of take-up valve, if applicable

9. Reinstall retaining snap ring and reservoir grommet (See Figure 1)

10. Reinstall reservoir on top of master cylinder

11. Fill reservoir three-quarters full with clean, approved brake fluid

CAUTION

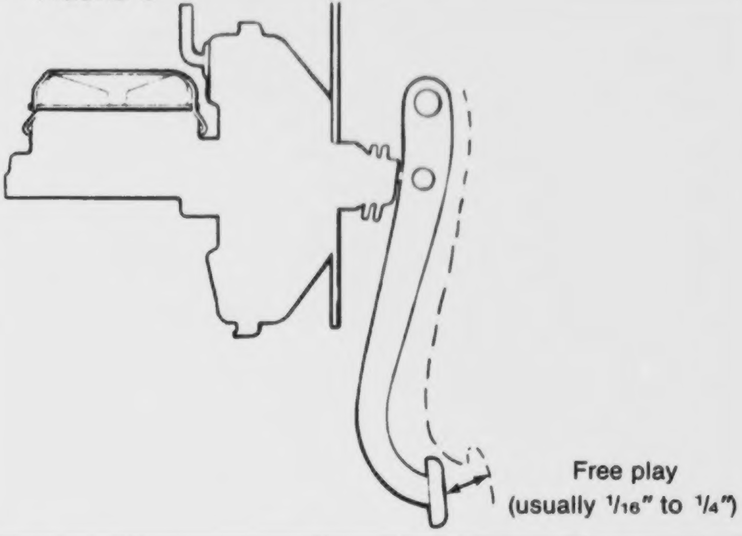
Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

12. Position reservoir diaphragm and cover over reservoir; snap cover bails firmly into place

13. Adjust brake pedal for correct free play

   a. Measure pedal free play at pedal pad (Figure 3)

FIGURE 3



Adapted with permission of Chrysler Corporation.

b. Adjust pedal to manufacturer's specifications at master cylinder or at power brake pushrod by increasing or decreasing overall length of rod or by repositioning rod in relation to pedal arm

NOTE: Some rods have a clevis and locknut threaded on the rod while others have a rod eye and are adjusted by rotating an eccentric bolt that attaches the eye to the pedal arm. Refer to service manual.

14. Bleed hydraulic system (Procedure Sheet 2)

15. Recheck fluid in master cylinder; refill with clean, approved brake fluid to at least three-quarters full if necessary

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

16. Road test vehicle

► WARNING ◄

Before road testing any vehicle, check fluid level in master cylinder, and depress brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that brakes are safe for road testing.

17. Clean work area and return equipment and materials to proper storage

JOB SHEET 8

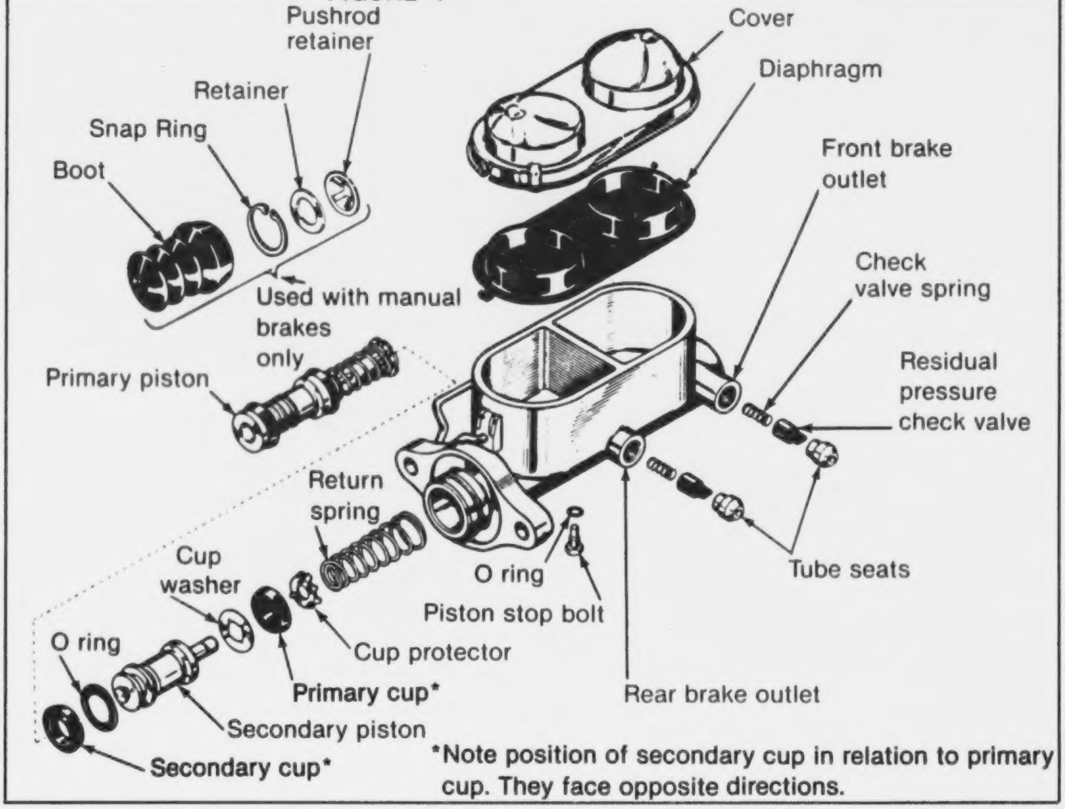
SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 23 **Overhaul a master cylinder**

INTRODUCTION

There are many design and construction differences in the master cylinders built by various manufacturers. Because those differences require different procedures for assembly and disassembly, you should always consult the service manual about the particular master cylinder you are overhauling. A typical master cylinder is illustrated below in Figure 1. The residual pressure check valve is used only with *drum* brake systems. It is never used with *disc* brake systems. However, some newer-model vehicles with drum brakes do not use the residual pressure check valve, rather using an expander cup in the wheel cylinders. The following steps give the procedure for overhauling the typical master cylinder shown in Figure 1.

FIGURE 1


Pushrod retainer
Retainer
Snap Ring
Boot
Used with manual brakes only
Primary piston
Cover
Diaphragm
Front brake outlet
Check valve spring
Residual pressure check valve
Return spring
Cup washer
O ring
Piston stop bolt
Tube seats
Cup protector
O ring
Primary cup*
Rear brake outlet
Secondary piston
Secondary cup*

*Note position of secondary cup in relation to primary cup. They face opposite directions.

Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Fender and seat covers
- Set of flare-nut wrenches
- Snap-ring pliers
- Screwdriver
- Brake bleeding equipment
- Diagonal side-cutting pliers
- Replacement check valve, tube seats, cups, and seals as necessary
- 1/4-inch-wide feeler shim
- Syringe
- Plugs for outlets and hydraulic lines
- Tubing or flare-nut wrenches
- Approved brake fluid
- Brake cylinder hone
- Crocus cloth
- Approved parts-cleaning fluid
- Bench vise
- Torque wrench
- Lint-free shop towels
- Self-tapping screw, 6-32 × 5/8″

PROCEDURE

1. Cover fenders and seats

2. Remove master cylinder from vehicle, following instructions in service manual

3. Wipe or brush off external dirt from master cylinder

4. Disassemble master cylinder

    a. Remove reservoir cover and diaphragm

    b. Use syringe to empty brake fluid from reservoirs

    CAUTION

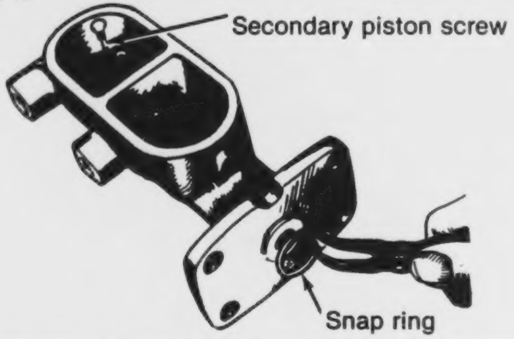
    Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

    c. Mount master cylinder in vise, taking care **not** to apply excessive pressure to the casting

    d. Remove secondary piston screw (See Figure 2)

    e. Remove primary piston snap ring and retainer (See Figure 2)

FIGURE 2


Secondary piston screw
Snap ring

f. Remove primary piston assembly

g. Remove secondary piston by tamping open end of master cylinder on bench or by using air pressure to force piston out of cylinder

CAUTION

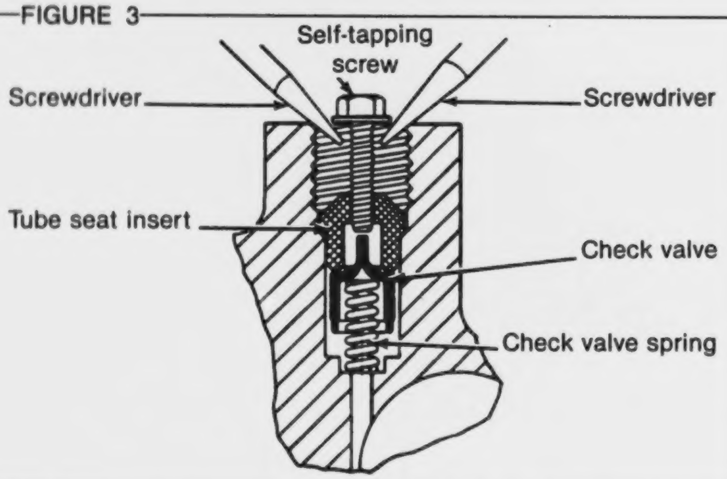
If using air pressure to remove the piston, place the open end of the cylinder against the bench.

h. Remove tube seats only *if* defective and replacement is recommended by manufacturer

   1) Thread 6-32 × $\frac{5}{8}$-inch self-tapping screw into defective tube seat

   2) Place ends of two screwdrivers under head of screw as shown in Figure 3; pry screw upward to pull tube seat from its bore

FIGURE 3


Self-tapping screw
Screwdriver
Screwdriver
Tube seat insert
Check valve
Check valve spring

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

i. Remove check valve and check valve spring if equipped

5. Clean and inspect parts

   a. Clean cylinder and parts to be reinstalled with approved cleaning fluid, using only lint-free wiping cloths, as lint can become trapped in bypass port passages and eventually plug them

   b. Clean minor scratches or signs of rust, corrosion, or discoloration from cylinder walls with crocus cloth, moving cloth in a circular rather than lengthwise direction

   c. Inspect cylinder bore for scoring and pitting

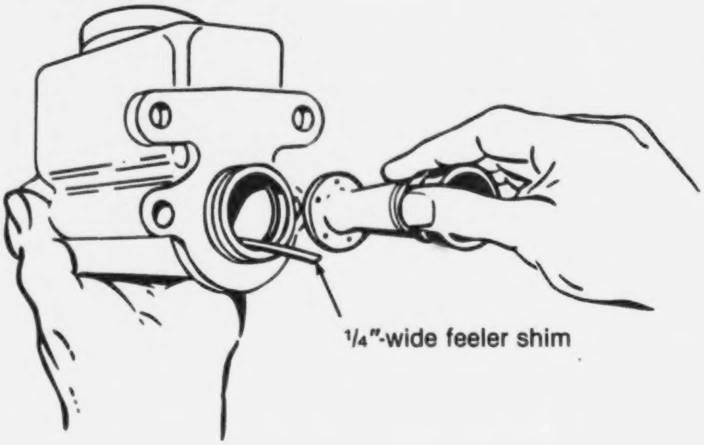
   d. Hone cylinder if necessary, taking care **not** to increase diameter more than 0.002 inch

      NOTE: *If* more honing is required, the master cylinder should be replaced rather than reconditioned.

   e. Remove any burrs formed on edge of intake or bypass ports

   f. Check cylinder for excessive piston clearance by placing a 1/4-inch-wide strip of feeler shim lengthwise in cylinder bore as shown in Figure 4; *if* piston can be inserted with shim in place, the cylinder is oversized and should be discarded.

FIGURE 4



Used with permission of Wagner Electric Corporation, from *Wagner Lockheed Manual AU-1600/July, 1970.*

g. Inspect pistons for scoring and corrosion; replace as necessary

NOTE: All cups and seals are replaced when reconditioning a master cylinder.

6. Reassemble master cylinder

a. Dip each internal part in clean brake fluid just before reassembly

b. Assemble new cups and seals on secondary piston, depressing cup lips with small, blunt probe to avoid nicking cup sealing edges

NOTE: The cup lip at the rear of the secondary piston must face the open (rear) end; all other cup lips face forward.

c. Install secondary piston return spring and secondary piston into cylinder

d. Holding primary piston in seated position, install piston retainer and snap ring, making sure that it is fully seated in its locking groove

e. Install secondary piston stop screw

f. Install residual check valve and spring if equipped

g. Install new tube seats *if* replacement is recommended by manufacturer

NOTE: The tube seats should **not** be removed or replaced unless they are damaged. Some manufacturers do not consider tube seat replacement to be a service operation. They recommend that the master cylinder be replaced if a tube seat is damaged. Use the following procedure *only* if tube seat replacement is recommended by the manufacturer.

1) Clean tube seat bore in outlet hole

2) Position new tube seat in outlet hole, making sure that it is **not** cocked

3) Using brake line nut as a press, turn nut down into outlet hole until tube seat bottoms in its bore

4) Remove tubing nut and inspect tube seat for any burrs that may have been formed; remove burrs if found

7. Bench bleed master cylinder (Procedure Sheet 8)

8. Reinstall master cylinder, following instructions in service manual

9. Bleed brake hydraulic system (Procedure Sheet 2)

10. Check master cylinder piston end play

    a. Pump brake pedal rapidly several times, and then hold firm pressure on pedal

    b. Release pressure on pedal while observing (or having a helper observe) master cylinder reservoirs for fluid creating a geyser while escaping from compensating port

    NOTE: If fluid movement is **not** detected in the reservoirs, the master cylinder pistons are **not** returning to their seats properly. This problem must be corrected before the brakes will operate properly.

11. Check master cylinder fluid level, and fill with clean, approved brake fluid to at least three-quarters full if necessary

    CAUTION

    Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

12. Reinstall reservoir diaphragm and cover, sealing securely with bails

13. Road test vehicle to test for proper brake operation

    ► WARNING ◄

    Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

14. Check for fluid leaks after road test

15. Clean work area and return equipment and materials to proper storage

JOB SHEET 9

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 24

Bench bleed a master cylinder

INTRODUCTION

Bench bleeding dual master cylinders before installation saves time and money. In order to expel all air trapped in the cylinder, dual master cylinders must be bench bled before they are installed on the vehicle. Bench bleeding reduces the possibility of air getting into the brake lines.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Bench vise
- Bench bleeding kit

NOTE: Bench bleeding kits are available that contain an assortment of fittings and tubing that will handle most domestic vehicles.

- Fender and seat covers
- Flare-nut or tubing wrench set
- Approved brake fluid
- Wooden dowel or smooth round-tipped rod

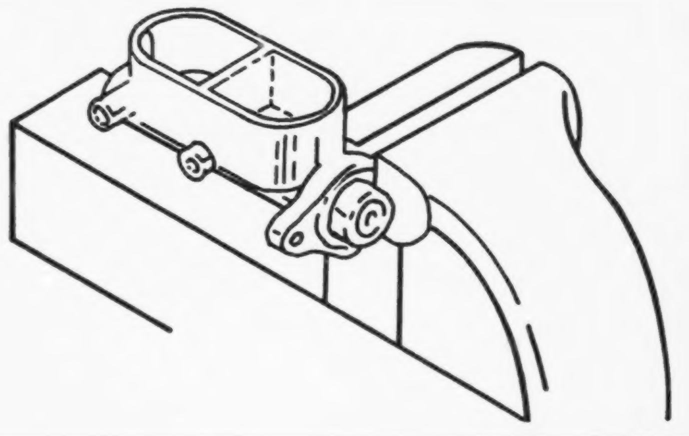
PROCEDURE

1. Mount master cylinder in vise, making sure that bore is horizontal, as shown in Figure 1

CAUTION

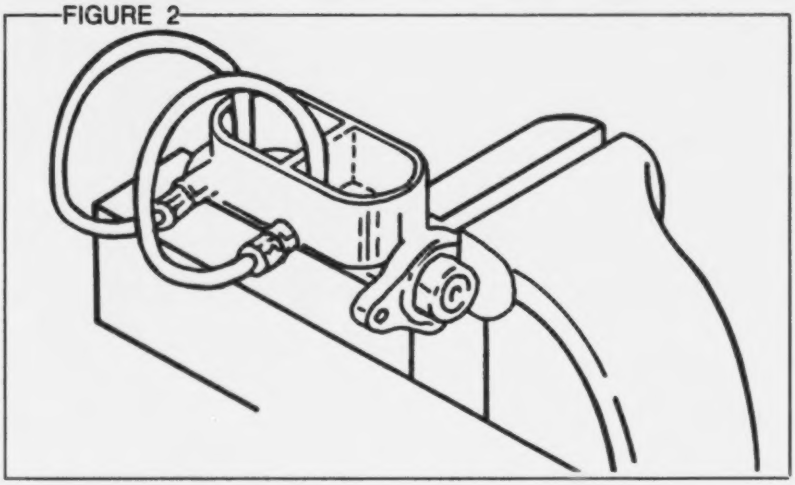
Do **not** apply excessive pressure to the casting.

FIGURE 1



2. Connect short lengths of tubing to outlet ports, and bend as shown in Figure 2.

FIGURE 2

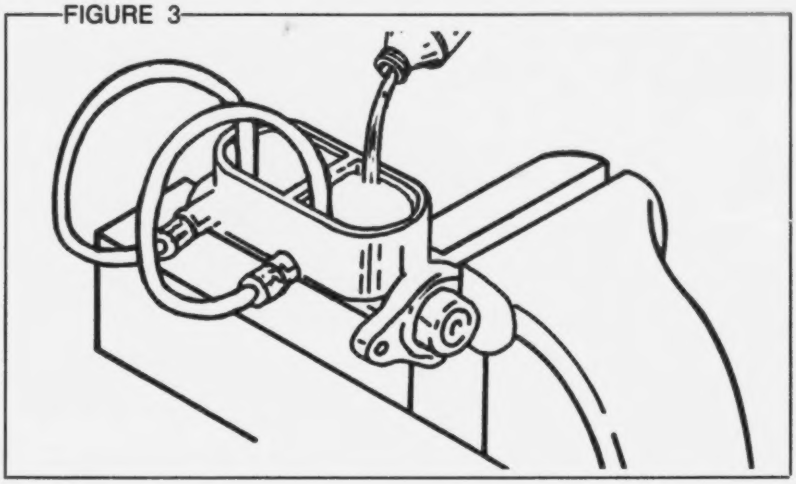


3. Fill reservoirs with fresh brake fluid, making sure that fluid level is well above ends of tubes (Figure 3)

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

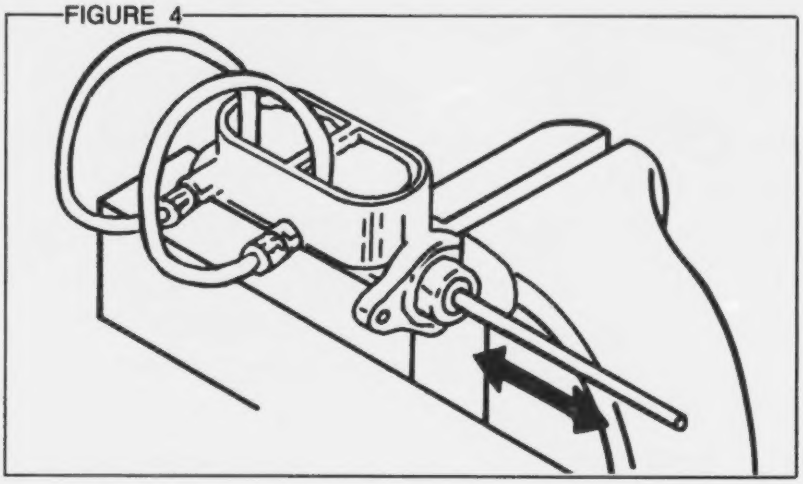
FIGURE 3



4. Slowly pump master cylinder with dowel or round-tipped rod until all bubbles stop appearing at tube ends; make sure that both pistons completely bottom in bore when you push dowel in and that both pistons return completely to the stop when you release dowel (Figure 4)

   NOTE: Slow piston return is normal on some master cylinders during bench bleeding.

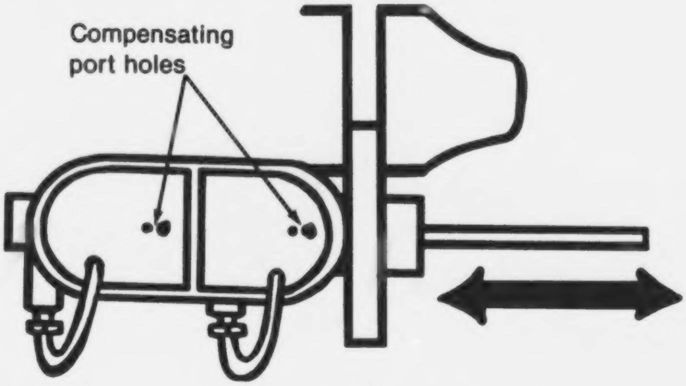
FIGURE 4



5. Push piston about 1/4 to 1/2 inch in from fully released position, allow piston to return about 1/8 inch, and then push it back to the initial 1/4 to 1/2 inch

6. Continue pumping rapidly in this manner until air bubbles stop coming from compensating ports located inside reservoirs (Figure 5)

FIGURE 5



7. Remove bleeder tubes and refill reservoirs with brake fluid

8. Securely install master cylinder diaphragm and cover

9. Cover fenders and seats

10. Install master cylinder on vehicle following service manual instructions and attaching lines but leaving tube connections loose

11. Have helper slowly depress brake pedal and hold it to floorboard

12. Tighten nuts at master cylinder tubing connections

13. Have helper release brake pedal

14. Loosen nuts at master cylinder tubing connections

15. Continue this process several times to force out any air that may have been trapped in the connections, tightening nut slightly before releasing pedal, and loosening it before depressing pedal each time

16. Catch fluid in rag to avoid damaging vehicle finish

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

17. Tighten connections to manufacturer's specifications when air bubbles are no longer present in fluid

18. Check master cylinder fluid level, and refill with clean, approved brake fluid to at least three-quarters full if necessary

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

19. *Before* attempting to move vehicle, check brake pedal to be sure that it is firm and high

20. Road test vehicle to check brake function

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

21. Clean work area and return equipment and materials to proper storage

This job sheet is adapted from *Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual AU-1600/Feb.*, 1984, by Wagner Division, Cooper Industries, Inc.

JOB SHEET 10

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 26

Remove and replace a combination valve

INTRODUCTION

A combination valve, as its name implies, combines all of the valves in a particular system. Such a valve can contain a pressure differential valve, a proportioning valve, and a metering valve. Combination valves are usually mounted on the frame, the bulkhead, or a side panel near the master cylinder. The position of such valves, their appearance, and their service procedures vary, even among vehicles made by the same manufacturer. Because of this, proper removal and installation procedures can be found only in the manufacturer's service manual. Certain guidelines, however, must be followed when replacing any hydraulic system valves. These guidelines are listed below.

Removal guidelines

- Strictly adhere to all asbestos safety rules.
- Always use tubing or flare-nut wrenches to remove lines from valves.
- Always support valve with an open-end wrench when you loosen the fittings (pliers are needed in some instances).
- Loosen all fittings before you loosen supporting bolts or clamps.
- Take care not to bend tubing when you disengage the flared ends; bent tubing may cause misalignment problems during reinstallation.

Installation guidelines

- Position all fittings and start all threads by hand.
- Do not use a wrench on any fitting until you are sure the threads are properly aligned and started.
- Do not tighten any fitting until all fittings have been started.
- After all fittings are hand-threaded in place, install attaching bolts or clamps.
- Use a tubing wrench to tighten all lines, supporting the valve if necessary.
- Thoroughly clean valve, fittings, and lines near valve to ensure detection of leaks.
- Bleed system in sequence specified by manufacturer.
- Check for leaks.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 11

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

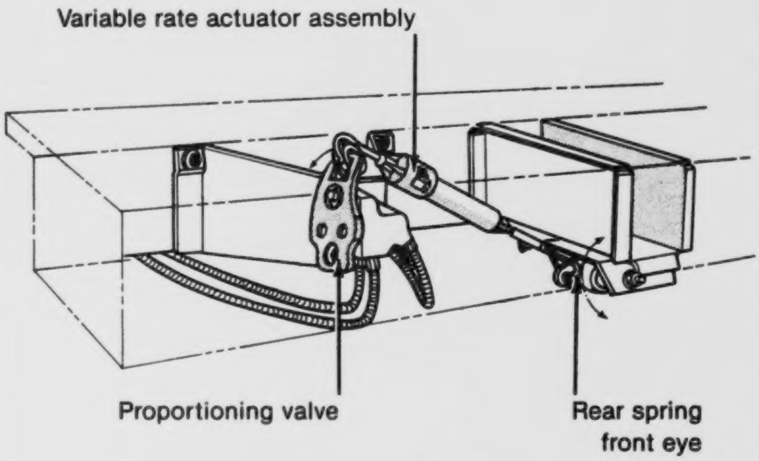
OBJECTIVE 27

Remove, adjust, and replace a load-sensing proportioning valve

INTRODUCTION

Load-sensing proportioning valves have been installed on some late-model vehicles. This system reduces the chance of rear wheel lockup while braking with a light cargo load and improves rear braking with heavier cargo loads. The system controls the amount of rear braking force according to the weight of the cargo load over the vehicle's rear axle. The load-sensing proportioning valve is mounted on the left side of the body or frame, and is connected to the rear axle through an actuator assembly. The actuator assembly contains two coil springs in series, thus providing a variable rate-of-increase of rear braking force with increasing cargo load. See Figure 1.

FIGURE 1



Used with permission of Chrysler Corporation.

If there is a light load on the rear wheels—as when there are no rear seat passengers or luggage, or during a hard stop that transfers weight to the front wheels—the proportioning valve pivot arm controls pressure by moving with the body angle to restrict passage of pressure through the valve. See Figure 2.

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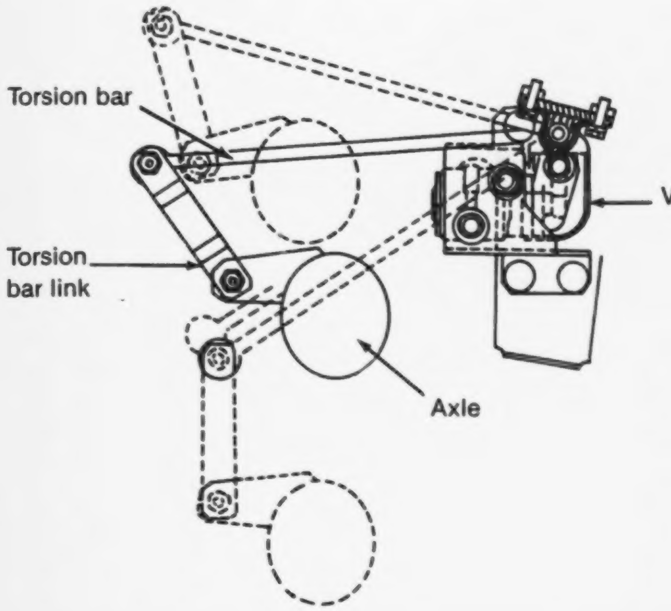
FIGURE 2



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

There should be no modifications *whatsoever* to this system. However, the brakes specialist should know how to remove and replace a load-sensing proportioning valve. Because removal and replacement procedures vary with vehicle make and model, the specialist must follow those procedures outlined in the appropriate service manual.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 12

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 28

Check and adjust brake stop light and warning light systems

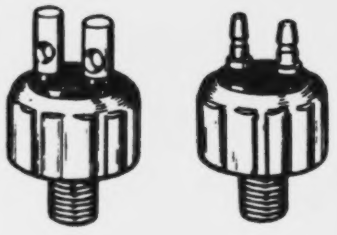
INTRODUCTION

Brake stop light switches

Brake stop light switches may be hydraulically or mechanically operated. They are basically spring-loaded electrical switches designed to turn the stop lights on when the brake pedal is depressed. Figures 1 and 2 show both hydraulic and mechanical stop light switches. In either type, the circuit through the switch is open when the brake pedal is released. When the pedal is depressed, the circuit through the switch closes, energizing the stop lights.

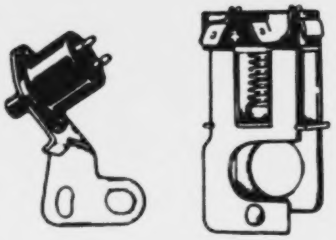
The hydraulic switch is operated by hydraulic pressure developed in the master cylinder. The mechanical switch is operated by contact with the brake pedal or with a bracket attached to the pedal lever under the dash.

FIGURE 1



Hydraulic switches

FIGURE 2



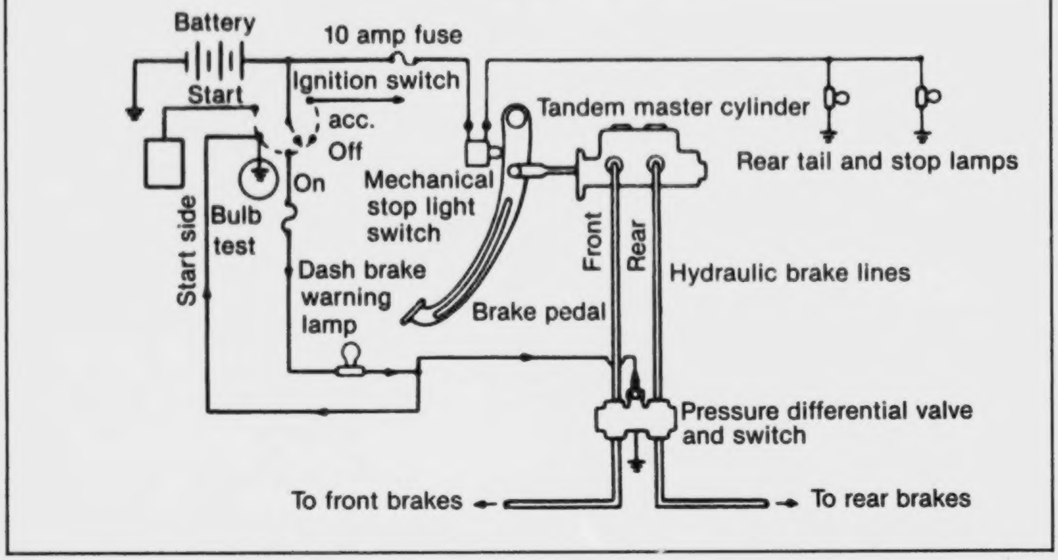
Mechanical switches

Figures 1 and 2 used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

Brake warning light switches

The brake warning light switch (pressure differential valve) was first used on 1967 models, along with the dual system master cylinder. On some disc-brake-equipped vehicles, beginning in 1970, this switch was combined with the proportioning valve into one housing. Usually, the valve body serves as a tubing junction, and the dual lines leading from the dual master cylinder are run parallel until joining the pressure differential valve and switch as shown in Figure 3 on the following page.

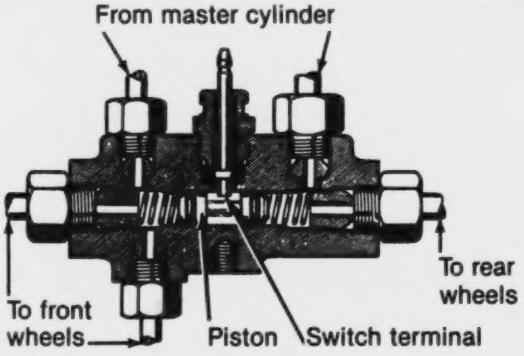
FIGURE 3


Battery
10 amp fuse
Ignition switch
Start
acc.
Off
On
Tandem master cylinder
Rear tail and stop lamps
Mechanical stop light switch
Bulb test
Start side
Front
Rear
Hydraulic brake lines
Dash brake warning lamp
Brake pedal
Pressure differential valve and switch
To front brakes
To rear brakes

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984*.

When operating normally, there is equal pressure on both sides of the piston, and the piston is centered below the switch terminal (the ends of the piston do not contact the switch terminal) as shown in Figure 4. When a brake failure occurs in either the front or rear system, there is unequal pressure on each side of the warning light switch piston. This causes the piston to move toward the side with low pressure; the end of the piston then contacts the switch terminal, completing the circuit. The warning switch then activates a warning light on the dashboard.

FIGURE 4


From master cylinder
To front wheels
Piston
Switch terminal
To rear wheels

Used with permission of General Motors Corporation, Chevrolet Motor Division.

It is important that the brake stop light and warning light systems operate properly so that the vehicle can be driven without endangering the operator and passengers or people in other vehicles. The brakes specialist must be able to check and adjust these systems. There are some differences in the design of the switches in the brake stop light and warning light systems, and these differences make it necessary to refer to the appropriate service manual for proper service procedures.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB
SHEET 13

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 35

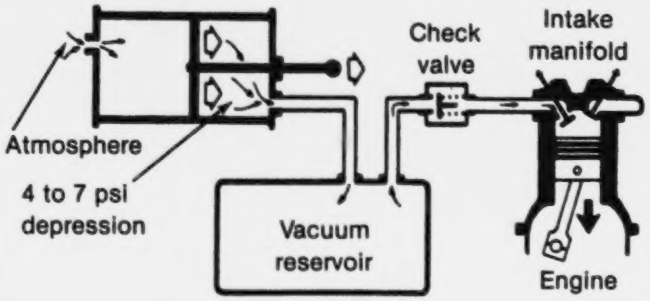
Inspect a vacuum power-assist unit and check valve for leaks and proper operation

INTRODUCTION

The power brakes found on most passenger cars and many commercial vehicles use vacuum power-assist units to supplement manual brake operation. Compressed-air boosters and full-powered air brakes are found only on heavier vehicles. Although the vacuum power brake units of various makes and models often appear quite different in shape or internal arrangement, these are mainly differences of structure, not of function. In most vacuum-powered systems, operating force is controlled by a valve mechanism and is exerted against the master cylinder piston when the brake pedal is depressed.

The vacuum power-assist unit obtains vacuum directly from the engine intake manifold or an engine-driven vacuum pump. See Figure 1.

FIGURE 1



Force = psi depression × area

EXAMPLE: 280 lb = 10 psi × 28 sq in

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Fender and seat covers
- Vacuum cylinder oil or nondetergent SAE 10 oil
- Approved brake fluid
- Vacuum gauge
- Brake system inspection report form

PROCEDURE

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Cover fenders and seats
2. Check master cylinder fluid level, and fill to at least three-quarters full with clean, approved brake fluid if necessary

   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

3. With engine off, operate brake pedal until system is devoid of vacuum
4. Hold pedal down firmly, and then start engine; *if* pedal does not fall away or pull down from your foot—indicating the presence of power assist—check power unit for proper operation by performing the following steps
   a. Run engine up to medium speed, then release throttle and turn off engine

   b. Wait for 1 or 2 minutes and then depress brake pedal

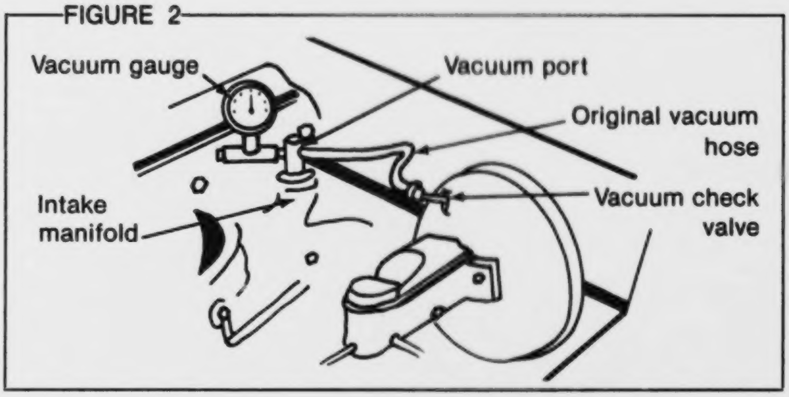
      NOTE: Vacuum in the reservoir should provide at least one fully boosted brake application before it becomes more difficult for the driver to depress the brake pedal (the pedal feels harder and higher).

   c. *If* you feel no power assist, the protection check valve or supply line is leaking, or vacuum supply is restricted to less than normal vacuum

   d. Test engine vacuum supply with a vacuum gauge

      (1) Attach vacuum gauge to an intake manifold vacuum connection (See Figure 2)

FIGURE 2

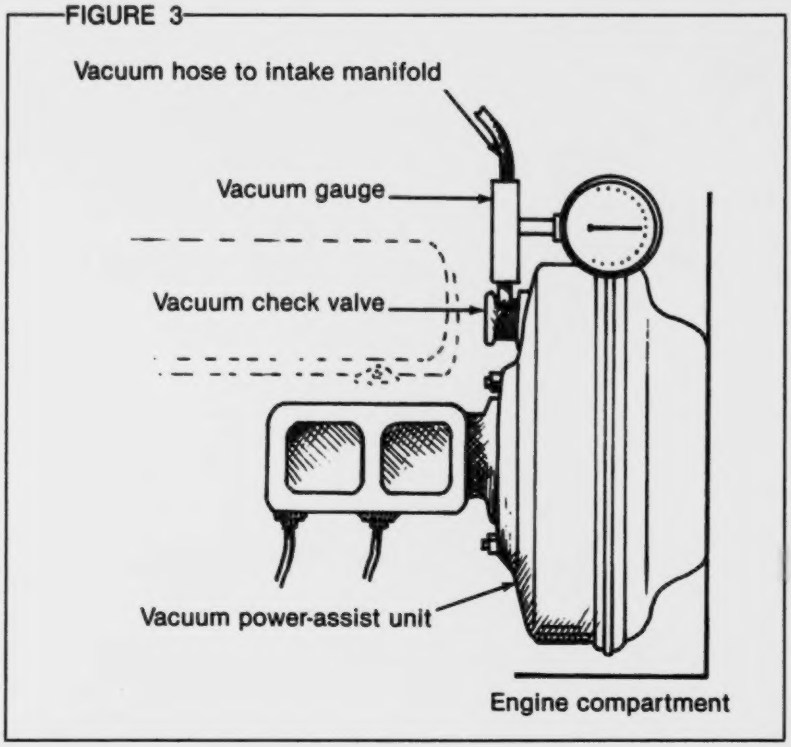

Vacuum gauge
Vacuum port
Original vacuum hose
Intake manifold
Vacuum check valve

(2) Start engine and take vacuum reading at idle speed; gauge should read at least 10 inches of vacuum; *if* it reads less than 10 inches, see service manual for repairs necessary to correct this condition

(3) Turn off engine and remove vacuum gauge from engine connection

(4) Connect gauge in vacuum hose at vacuum power-assist unit check valve as shown in Figure 3

FIGURE 3


Vacuum hose to intake manifold
Vacuum gauge
Vacuum check valve
Vacuum power-assist unit
Engine compartment

   (5) Start engine and take vacuum reading at idle speed; reading should be the same as that taken at manifold; *if* reading is lower, inspect for a leak or restriction in the hose

   (6) Turn off engine

5. Disconnect supply line at power unit and check it for presence of brake fluid; *if* brake fluid is present and unit is installed downstream from master cylinder, seals within unit are leaking; *if* unit is installed in pedal linkage, a vacuum seal within unit and the piston secondary seal in master cylinder are both leaking

6. Check for reserve vacuum leaks

   a. Operate engine at fast idle for 10 seconds and then turn off engine

   b. Let vehicle stand for 10 minutes

   c. Apply brake pedal with approximately 20 pounds of force; *if* pedal feels hard, replace vacuum check valve and retest for leaks; *if* pedal still feels hard, replace power-assist unit

7. Lubricate power-assist unit by inserting vacuum cylinder oil or nondetergent SAE 10 oil directly into cylinder through pipe plug or lead-in tube connection at end opposite vacuum supply line connection

   NOTE: Vacuum-powered, piston-type units should be lubricated at brake inspection intervals; otherwise, a dry packing or cup lip could result in internal leakage or cause noisy operation.

8. *If* unit includes an air filter that can be cleaned, service it

9. Check fluid level in master cylinder reservoir; refill with clean, approved brake fluid to at least three-quarters full if necessary

   CAUTION

   Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

10. Road test vehicle

   ► WARNING ◄

   Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

11. Clean work area and return equipment and materials to proper storage

JOB SHEET 14

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 36

Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation

INTRODUCTION

This hydraulic power-assist system differs from vacuum power-assist units not only in the source of power (hydraulic versus vacuum), but in the fact that it is also a part of another major subsystem of the vehicle—the power steering system. Therefore, problems or malfunctions in the steering system may affect the operation of the unit, just as a problem in the power unit may affect the steering system.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- Fender and seat covers
- Power steering fluid recommended by vehicle manufacturer
- Approved brake fluid

CAUTION

Power steering fluid and brake fluid **cannot** be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will occur.

- Replacement steering pump belt if needed
- Booster seal kit
- Screwdriver
- Pliers
- Shop towels
- Replacement parts as needed
- Basin for catching accumulator fluid
- Torque wrench
- Brake system inspection report form

PROCEDURE

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Cover fenders and seats
2. Check all power steering and brake lines and connections for leaks and restrictions
3. Check master cylinder fluid level, and fill to at least three-quarters full with clean, approved brake fluid if necessary

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

4. Check fluid level in power steering pump reservoir; fill with power steering fluid, taking care **not** to mix the fluid with air

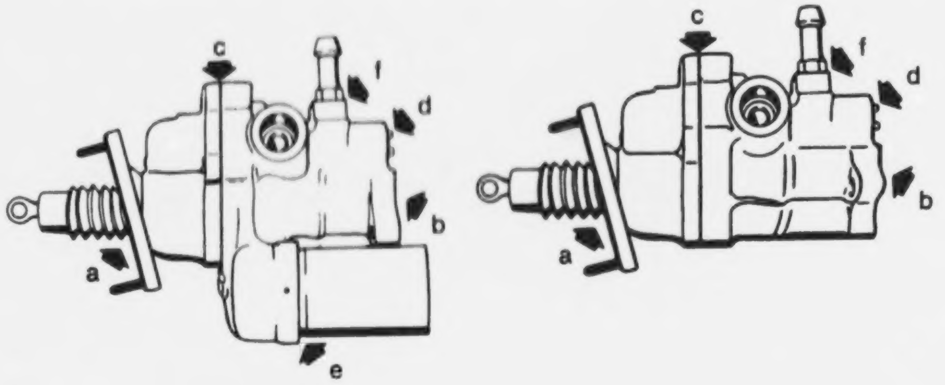
5. Check power steering pump belt for tension and damage; replace if necessary

6. Check engine idle speed and adjust according to service manual recommendations if necessary

7. Check steering pump pressure and adjust according to service manual recommendations if necessary

8. Check for seal leaks in appropriate locations as indicated on the illustrations of GM Hydro-Boost I and Hydro-Boost II systems in Figure 1 below

FIGURE 1



Hydro-Boost I **Hydro-Boost II**

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

a. **Input rod seal** — Check for fluid leak from mounting bracket vent hole; *if* seal is damaged, the booster must be removed from vehicle to replace seal

b. **Power piston seals** — Check for fluid leaking at common master cylinder/brake booster vent; *if* seals are damaged, booster must be removed from vehicle and disassembled to repair

NOTE: Check piston for scratches that may be causing a leak. *If* scratches are deep and extensive, replace piston following manufacturer's directions; *if* scratches are present but not excessive, replace appropriate seals with booster seal kit.

c. **Housing seal** — Check for fluid leaking out from between the two housings; *if* housing is damaged, the booster must be removed from vehicle and booster seal kit and used to replace housing and power piston seals

d. **Spool valve plug O-ring seal** — Check for fluid leaking past plug; *if* seal is damaged, follow the steps below to replace

   (1) Press in on spool plug and insert small screwdriver between snap ring and housing bore to unseat one side of spool plug snap ring from its groove in bore

   (2) Remove snap ring from its groove in bore

   (3) Withdraw plug from bore with pliers

   (4) Remove O ring from plug and replace it with a new one

   (5) Clean any dirt or rust from plug bore with clean power steering fluid to make sure that no dirt or rust is introduced into power unit

   (6) Push end plug back into bore and secure it with new retaining ring

e. **Accumulator O-ring seal (on Hydro-Boost I models only)** — Check for fluid leakage past accumulator cap; *if* seal is damaged, replace, following procedure recommended in vehicle service manual

CAUTION

Before removing accumulator spring cap, place a basin under the power unit to catch fluid when the cap is removed. Also, before the cap is removed, the brake pedal should be pumped four or five times to deplete accumulator pressure.

f. **Return port fitting** — Check port for external leakage; *if* there is leakage, tighten fitting to specified torque; *if* fitting continues to leak, replace O ring under fitting

9. Check high-pressure gear or pump port for leakage; *if* there is leakage, torque tube nut to manufacturer's specifications; *if* leakage persists, check for damaged tube flares and repair if needed; *if* tube flares are good, replace the tube seats

10. Perform accumulator leakdown test

    a. Start engine and charge accumulator either by applying brake pedal (use about 100 pounds of pressure) or by turning steering wheel from stop to stop

    b. Turn off engine and allow vehicle to sit for 1 hour

    c. *If* system is Hydro-Boost I, apply brake pedal twice with engine off; *if* system is Hydro-Boost II, apply brake pedal once with engine off

    NOTE: There should be enough residual pressure for two brake applications. *If* there is not enough residual pressure, the vacuum valve is leaking. Refer to vehicle service manual.

11. Perform power unit function test

    a. With engine off, apply brake pedal several times until accumulator is completely depleted of pressure

    b. Depress brake pedal (using approximately 40 pounds of force) and start engine; pedal should move down and then push back against your foot; *if* it does not, the power unit is defective and requires replacement

12. Clean work area and return equipment and materials to proper storage

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JOB SHEET 15

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

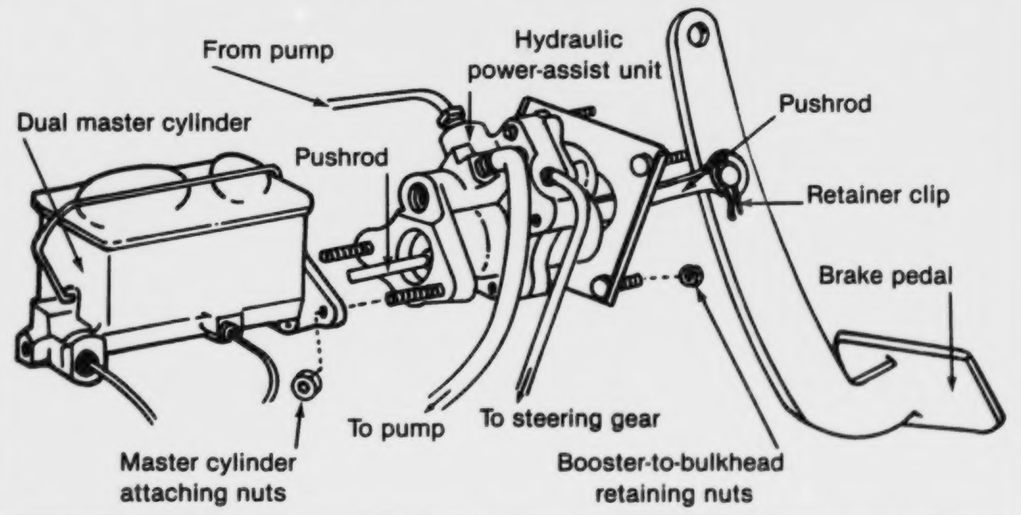
OBJECTIVE 37

Test, remove, and install a hydraulic power-assist unit (mechanical pump)

INTRODUCTION

With this type of power-assist unit, the power steering pump provides hydraulic fluid under pressure to the booster unit as well as to the power steering gear. The power-assist unit is mounted to the bulkhead and connected to the brake pedal by a pushrod that is an integral part of the power brake unit. A dual master cylinder is bolted to the power unit as shown in Figure 1 below, and is operated by the pushrod connecting them. In this design, an accumulator stores enough fluid under pressure to provide two power-assisted stops in case of a system pressure loss.

FIGURE 1


From pump
Hydraulic power-assist unit
Dual master cylinder
Pushrod
Pushrod
Retainer clip
Brake pedal
To pump
To steering gear
Master cylinder attaching nuts
Booster-to-bulkhead retaining nuts

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service,* ©1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers
- Power steering fluid
- Approved brake fluid

CAUTION

Power steering fluid and brake fluid **cannot** be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will occur.

- Flare-nut or tubing wrench set
- Shop towels
- Bleeder screw wrench
- Torque wrench
- Eye protection

PROCEDURE

1. Cover seats and fenders
2. Refer to service manual and perform the following preliminary checks
    - Check for amount of brake fluid
    - Check for correct amount of power steering pump fluid
    - Check for proper tension in power steering pump belt
    - Check for proper engine idle speed
3. Test hydraulic power-assist unit
    a. With ignition off, pump brake pedal several times to deplete accumulator of all reserve fluid stored under pressure

    b. With transmission in NEUTRAL and brake pedal in applied position, start engine
        - *If* brake pedal moves down slightly and then pushes back against your foot, the power-assist unit is operating correctly
        - *If* no action is felt, the power-assist unit is defective and must be replaced

CAUTION

Most power-assist units require the use of special tools and spring retaining devices for disassembly and assembly. Some manufacturers advise against any attempt to overhaul these units and do not list parts for them in their catalogs. For these reasons, most mechanics usually replace a faulty booster unit with a new unit or with one that has been overhauled by a shop that specializes in rebuilding booster units.

NOTE: On a hydraulic power-assist system, it is also necessary to perform an accumulator leakdown test to make sure that there is enough reserve accumulator pressure to stop the vehicle in case the engine stops running, the power steering belt breaks, or a loss of power steering fluid occurs. Refer to the appropriate service manual for this procedure.

4. Remove hydraulic power-assist unit

    a. With ignition off, apply brake several times to lower pressure in accumulator

    b. Remove nuts attaching master cylinder to power unit (See Figure 1)

    NOTE: It is not necessary to remove the brake lines.

    c. Remove the three hydraulic lines from power unit (See Figure 1)

    d. Remove pushrod retainer clip, and then slide pushrod from brake pedal

    e. Remove booster-to-bulkhead retaining nuts, and lift unit from bulkhead

5. Install hydraulic power-assist unit

    a. Position power unit on bulkhead, and then install pushrod on brake pedal and lock it in place with its washer and retainer clip

    b. Install booster-to-bulkhead retaining nuts; torque to vehicle manufacturer's specifications

    c. Install master cylinder on power unit; torque master cylinder retaining nuts to vehicle manufacturer's specifications

    d. Install the three hydraulic lines on power unit

    e. Disconnect source of power to ignition system as specified in service manual

    NOTE: On GM diesel engines, you must disconnect the 12-volt wire from the fuel injector pump.

6. Fill power steering pump reservoir with power steering fluid

7. While engaging starter, pump brakes in order to purge air from system

CAUTION

Do **not** turn the steering wheel until all air is purged from the system.

8. Check power steering reservoir fluid level; add power steering fluid if necessary

9. Reconnect ignition system or diesel pump, following service manual instructions

10. With transmission in NEUTRAL, start engine

11. Pump brakes again, turning steering wheel one full cycle from left to right

12. Check for fluid leaks

13. Recheck fluid level in master cylinder reservoir, and refill with clean, approved brake fluid to at least three-quarters full if necessary

    CAUTION

    Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

14. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

15. Clean work area and return equipment and materials to proper storage

JOB SHEET 16

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

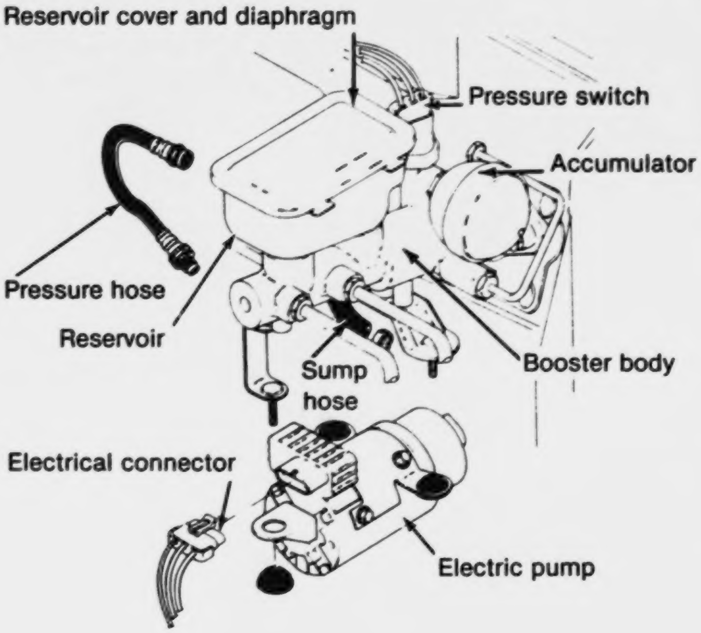
OBJECTIVE 38

Inspect and overhaul a hydraulic power-assist unit (electrical pump)

INTRODUCTION

This hydraulic power-assist system is fairly new on the market and differs from the mechanically pumped hydraulic system in that it does not derive its pressure from the power steering system, but instead uses an electrical pump as shown in Figure 1 below. In this system, the nitrogen-charged accumulator stores fluid for hydraulic booster operation. The electric pump operates between pressure switch limits with the ignition ON. When the pressure switch senses accumulator pressure below specified limits, the pump operates to increase accumulator fluid pressure. When the brake pedal is depressed, fluid from the accumulator acts on the booster power piston to apply the master cylinder, which functions in the same manner as a conventional master cylinder.

FIGURE 1


Reservoir cover and diaphragm
Pressure switch
Accumulator
Pressure hose
Reservoir
Sump hose
Booster body
Electrical connector
Electric pump

Used with permission of General Motors Corporation, Delco Moraine Motor Division.

Because of design and installation variations, the brakes specialist must follow instructions in the vehicle service manual when servicing this type of power-assist unit. However, some general guidelines apply to all designs, and those are listed below.

Inspection guidelines

- Be sure to note all inspection results on brake system inspection report form.
- Inspect all metal parts for cracks, distortion, or other evidence of structural damage.
- Inspect primary sealing surfaces on power piston for scoring, deep scratches, or other damage that could cause leakage; if noted, replace power piston assembly.
- Inspect power piston and master cylinder piston bores in booster body for scoring and corrosion; if noted, replace power brake assembly (bores must not be honed).
- Inspect all grommets and rubber parts for wear and deterioration; if noted, install new rubber parts as specified in service manual.
- Inspect for leaks at brake pedal pushrod, reservoir cover, hose and pipe connections, reservoir attaching points, pressure switch, and accumulator.

Overhaul guidelines

CAUTION

Most power-assist units require the use of special tools and spring retaining devices for disassembly and assembly. Some manufacturers advise against any attempt to overhaul these units and do not list parts for them in their catalogs. For these reasons, most mechanics usually replace a faulty booster unit with a new unit or with one that has been overhauled by a shop that specializes in rebuilding booster units. If you have to overhaul a power-assist unit, you should first study the procedure outlined by the unit manufacturer. Proceed only if the proper tools and equipment are available. Any attempt to disassemble a booster unit without using the proper tools and holding devices may release spring-loaded parts and cause you personal injury.

- Fully depressurize power unit before performing any service. Failure to depressurize the power unit could lead to personal injury and damage to painted surfaces.

- Perform any disassembly procedures on a clean bench free of all mineral oil.
- Take care not to scratch or otherwise damage sealing surfaces at pushrod end of power piston assembly and bores in booster body.
- Clean all parts except pressure switch and electric pump in denatured alcohol.

  NOTE: The exterior surfaces of the pump may be wiped with a cloth dampened with denatured alcohol, but neither the pump or the pressure switch should ever be wetted or immersed.
- Use clean, fresh brake fluid to lubricate parts before reassembly.
- Lubricate new rubber O rings, grommets, and seals with clean brake fluid just before reassembly.
- Lubricate master cylinder and power piston bores in booster body before installing parts.
- Do not use lubricated shop air on brake parts as damage to rubber components may result.
- Follow service manual instructions for bleeding and filling booster unit and cycling pump.
- Follow service manual instructions for bleeding master cylinder section of power booster unit.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 17

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 40

Diagnose an antiskid system and replace faulty components

INTRODUCTION

Maximum braking happens just before each tire stops turning and starts to slide. It is very difficult to manually maintain such fine control over braking, especially when the four tires have a different amount of traction. Traction varies with such factors as sand, snow, ice, water, bumps, vehicle load, and weight transfer. Special skid-control brakes systems (sometimes called *brake antilock systems*) use electronics to sense wheel lockup and modulate braking at the wheel many times per second. Antiskid systems use electric sensors that monitor wheel rotation versus the vehicle's speed. A computer then tells a hydraulic modulator to release or restore brake line pressure as needed. Presently, high costs restrict antiskid systems to being an option on expensive automobiles.

When working with an antiskid system, always follow these guidelines:

- Before attempting any type of repair on this unit, the accumulator must be totally discharged. This is accomplished by applying the brakes 15 to 20 times with electrical power to the system disconnected.
- Safety glasses should be worn at all times while working on this system. Hydraulic pressures can exceed 2000 psi in some stages of operation, so extreme care should be observed when disconnecting lines or bleeding the brakes.
- Because of the high pressures involved with this system—1200 psi to 3000 psi—it is imperative that new seals be used and that damaged or worn parts be replaced.

Because exact skid-control systems vary, the brakes specialist must refer to the vehicle service manual for more details of system operation and service.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

CAUTION

No adjustment or repairs should be made to an antiskid braking system. Damaged or worn parts must be replaced.

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 1

Inspect, test and service hydraulic brake lines and hoses

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Inspected lines and fittings following outlined procedure for conditions listed in job sheet.	______	______
3. Inspected hoses following outlined procedure for conditions listed in job sheet.	______	______
4. Replaced brake lines following outlined procedure.	______	______
5. Selected correct replacement tubing.	______	______
6. Replaced brake hoses following outlined procedure.	______	______
7. Selected correct replacement hose.	______	______
8. Handled brake hoses properly.	______	______
9. Completed service correctly.	______	______
10. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
11. Correctly filled out brake system inspection report form.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 2

Bleed or flush a hydraulic braking system

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Determined hydraulic system circuit(s) to be bled.	______	______
3. Bled system at bleeder points in correct sequence.	______	______
4. Manually bled hydraulic system following outlined procedure.	______	______
5. Pressure bled hydraulic system following outlined procedure.	______	______
6. Surge bled hydraulic system following outlined procedure.	______	______
7. Centered pressure differential valve, if necessary, following outlined procedure.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 3

Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed front disc brake bearing assemblies following outlined procedure.	______	______
4. Removed drum brake bearing assemblies (front-wheel drive) following outlined procedure.	______	______
5. Cleaned and inspected bearing assemblies following outlined procedure.	______	______
6. Correctly determined if each wheel bearing assembly and race should be replaced.	______	______
7. Repacked (or packed) bearing assemblies with bearing packer following outlined procedure.	______	______
8. Repacked (or packed) bearing assemblies by hand following outlined procedure	______	______
9. Reinstalled packed cone-and-roller assemblies and grease seals following outlined procedure.	______	______
10. Reinstalled brake and wheel assemblies following outlined procedure.	______	______
11. Completed service correctly.	______	______
12. Observed safety rules and precautions.	______	______
13. Correctly filled out brake system inspection report form.	______	______
14. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 4

Adjust wheel bearings

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Torqued spindle nut to manufacturer's specifications and seated bearings.	______	______
4. Retorqued or tightened spindle nut according to manufacturer's instructions.	______	______
5. Correctly attached dial indicator and measured looseness in hub assembly.	______	______
6. Retorqued spindle nut to manufacturer's specifications, reinstalled nut lock, and installed new cotter pin.	______	______
7. Reinstalled dust cap on hub and replaced wheel cover.	______	______
8. Bled hydraulic system.	______	______
9. Completed service correctly.	______	______
10. Observed safety rules and precautions.	______	______
11. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 5

Remove and replace front-wheel-drive nonserviceable sealed wheel bearings

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed tire-and-wheel assemblies correctly.	______	______
4. Removed and suspended caliper correctly.	______	______
5. Removed bearings following procedure outlined in vehicle manufacturer's service manual.	______	______
6. Performed necessary preparations for removing and installing bearings.	______	______
7. Replaced bearings following procedure outlined in vehicle manufacturer's service manual.	______	______
8. Reinstalled caliper correctly.	______	______
9. Reinstalled tire-and-wheel assemblies correctly.	______	______
10. Completed service correctly.	______	______
11. Observed safety rules and precautions.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 6

Remove and replace a dual master cylinder

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed dual master cylinder following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Discarded and replaced all rubber parts.	______	______
5. Dipped master cylinder components in clean brake fluid before assembly.	______	______
6. Replaced dual master cylinder following procedure outlined in vehicle manufacturer's service manual.	______	______
7. Adjusted brake pedal free play correctly.	______	______
8. Tested master cylinder vents at both ports.	______	______
9. Bled brakes.	______	______
10. Completed service correctly.	______	______
11. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 7

Remove and replace a take-up valve in a quick take-up master cylinder

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed quick take-up valve assembly following outlined procedure.	______	______
4. Installed replacement take-up valve following outlined procedure.	______	______
5. Reinstalled master cylinder reservoir and filled reservoir correctly.	______	______
6. Adjusted brake pedal for correct free play.	______	______
7. Bled hydraulic system.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 8

Overhaul a master cylinder

Student's name ______________________________ Date ___________

Evaluator's name ______________________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed master cylinder from vehicle following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Disassembled master cylinder following outlined procedure.	______	______
5. Cleaned and inspected parts following outlined procedure.	______	______
6. Reassembled master cylinder following outlined procedure.	______	______
7. Reinstalled master cylinder following procedure outlined in vehicle manufacturer's service manual.	______	______
8. Bled brake system.	______	______
9. Checked master cylinder piston end play.	______	______
10. Completed service correctly.	______	______
11. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 9

Bench bleed a master cylinder

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared master cylinder for bench bleeding.	______	______
3. Bench bled master cylinder following outlined procedure.	______	______
4. Properly prepared vehicle.	______	______
5. Installed master cylinder on vehicle following procedure outlined in vehicle manufacturer's service manual.	______	______
6. Remove air trapped in connections following outlined procedure.	______	______
7. Tightened connections to vehicle manufacturer's specifications.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 10

Remove and replace a combination valve

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. ______

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed combination valve following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Installed combination valve following procedure outlined in vehicle manufacturer's service manual.	______	______
5. Thoroughly cleaned valve, fittings, and lines near valve.	______	______
6. Bled system in sequence specified by manufacturer.	______	______
7. Checked for leaks.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions, including proper handling of brake fluid.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 11

Remove, adjust, and replace a load-sensing proportioning valve

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed valve following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Made adjustments following procedure outlined in vehicle manufacturer's service manual.	______	______
5. Replaced valve following procedure outlined in vehicle manufacturer's service manual.	______	______
6. Bled brake system.	______	______
7. Completed service correctly.	______	______
8. Observed safety rules and precautions.	______	______
9. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 12

Check and adjust brake stop light and warning light systems

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Checked and adjusted brake stop light system following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Checked and adjusted brake warning light system following procedure outlined in vehicle manufacturer's service manual.	______	______
5. Completed service correctly.	______	______
6. Observed safety rules and precautions.	______	______
7. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 13

Inspect a vacuum power-assist unit and check valve for leaks and proper operation

Student's name ______________________________ Date ___________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Checked power unit for proper operation following outlined procedure.	______	______
4. Correctly determined seal leakage.	______	______
5. Checked for reserve vacuum leaks following outlined procedure.	______	______
6. Lubricated power-assist unit following outlined procedure.	______	______
7. Completed service correctly.	______	______
8. Observed safety rules and precautions.	______	______
9. Correctly filled out brake system inspection report form.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 14

Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Checked for seal leaks in appropriate locations following outlined procedure.	______	______
4. Replaced parts as necessary following correct procedures.	______	______
5. Checked high-pressure gear or pump port for leakage, making corrections as necessary.	______	______
6. Performed accumulator leakdown test following outlined procedure.	______	______
7. Performed power unit function test following outlined procedure.	______	______
8. Observed safety rules and precautions.	______	______
9. Correctly filled out brake system inspection report form.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 15

Test, remove, and install a hydraulic power-assist unit (mechanical pump)

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Tested hydraulic power-assist unit following outlined procedure.	______	______
4. Correctly determined whether power-assist unit operates correctly or should be replaced.	______	______
5. Removed hydraulic power-assist unit following outlined procedure.	______	______
6. Install hydraulic power-assist unit following outlined procedure.	______	______
7. Filled power steering pump reservoir with power steering fluid.	______	______
8. Pumped brakes to purge air from system, and added power steering fluid if necessary.	______	______
9. Reconnected ignition system or diesel pump following procedure outlined in vehicle manufacturer's service manual.	______	______
10. Checked for fluid leaks.	______	______
11. Completed service correctly.	______	______
12. Observed safety rules and precautions.	______	______
13. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 16

Inspect and overhaul a hydraulic power-assist unit (electrical pump)

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Performed inspection following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Replaced parts as necessary, following manufacturer's instructions.	______	______
5. Fully depressurized unit before performing any service.	______	______
6. Inspected and serviced hydraulic power-assist unit following procedure outlined in vehicle manufacturer's service manual.	______	______
7. Cleaned and lubricated parts as recommended.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions.	______	______
10. Correctly filled out brake system inspection report form.	______	______
11. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 17

Diagnose an antiskid system and replace faulty components

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Diagnosed antiskid system following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Replaced faulty components following procedure outlined in vehicle manufacturer's service manual.	______	______
5. Completed service correctly.	______	______
6. Observed safety rules and precautions.	______	______
7. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

WRITTEN TEST

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

Name ______________________ Score ____________

OBJECTIVE 1

Choose the definitions that best define the following terms associated with the brake hydraulic system. Write the correct numbers in the blanks.

_____a. **Bleeding**

1. Process by which air and contaminants are removed from hydraulic system by draining part of the fluid or by operating system to work out these contaminants
2. Process by which dirt is removed from hydraulic fluid by aerating the fluid with compressed air
3. Process by which friction is reduced in hydraulic system by lubricating the system with silicone grease

_____b. **Brake**

1. Device used to slow, stop, or hold a vehicle by changing potential energy of motion into useless and wasted kinetic energy
2. Device used to slow, stop, or hold a vehicle by changing kinetic energy of motion into heat energy
3. Device used to slow, stop, or hold a vehicle by changing heat energy into useless and wasted kinetic energy

_____c. **Brake fluid**

1. Silicone-based liquid used in hydraulic brake systems to transmit force through tubing known as *brake lines*
2. Petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as *brake lines*
3. Non-petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as *brake lines*

_____d. **Asbestosis**

1. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
2. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos
3. Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

_____e. **Check valve**

1. Device that reduces pressure to rear wheels during hard braking
2. Device that prevents hydraulic pressure to front brakes until after rear brakes are applied
3. Device that allows air or liquid to pass in one direction only

_____f. **Dual master cylinder**

1. Component of the hydraulic system that converts driver force to hydraulic pressure; contains four pistons, two each serving two wheel brakes
2. Component of the hydraulic system that converts driver force to hydraulic pressure; contains two pistons, each piston serving two wheel brakes
3. Component of the hydraulic system that converts driver force to hydraulic pressure; contains one piston that serves the two wheel brakes

_____g. **Flushing**

1. Process of removing all air from hydraulic system and replacing it with new air
2. Process of using compressed air to remove all contaminants from hydraulic system
3. Process of removing all old fluid from hydraulic system and replacing it with new fluid

_____h. **Free play (brake)**

1. Clearance between release bearing and pressure plate felt as motion at clutch pedal
2. Clearance between master cylinder actuator rod and piston assembly
3. Clearance between brake drum or disc and shoe or pad felt as clearance at brake pedal

______i. **Hydraulic power-assist unit**

1. Device that uses hydraulic pressure supplied by intake manifold to assist in applying brakes
2. Device that uses vacuum pressure supplied by accumulator to assist in applying brakes
3. Device that uses hydraulic pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

______j. **Lung cancer**

1. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
2. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposure to asbestos
3. Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

______k. **Mesothelioma**

1. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
2. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos
3. Fatal cancer of the lining of the chest or nasal mucous membranes caused by prolonged exposure to asbestos

______l. **Overhaul**

1. To disassemble, recondition worn parts, replace defective parts, and reassemble a component or assembly
2. To remove a component or assembly and replace it with a new or reconditioned component or assembly
3. To machine or return a part to its original surface condition

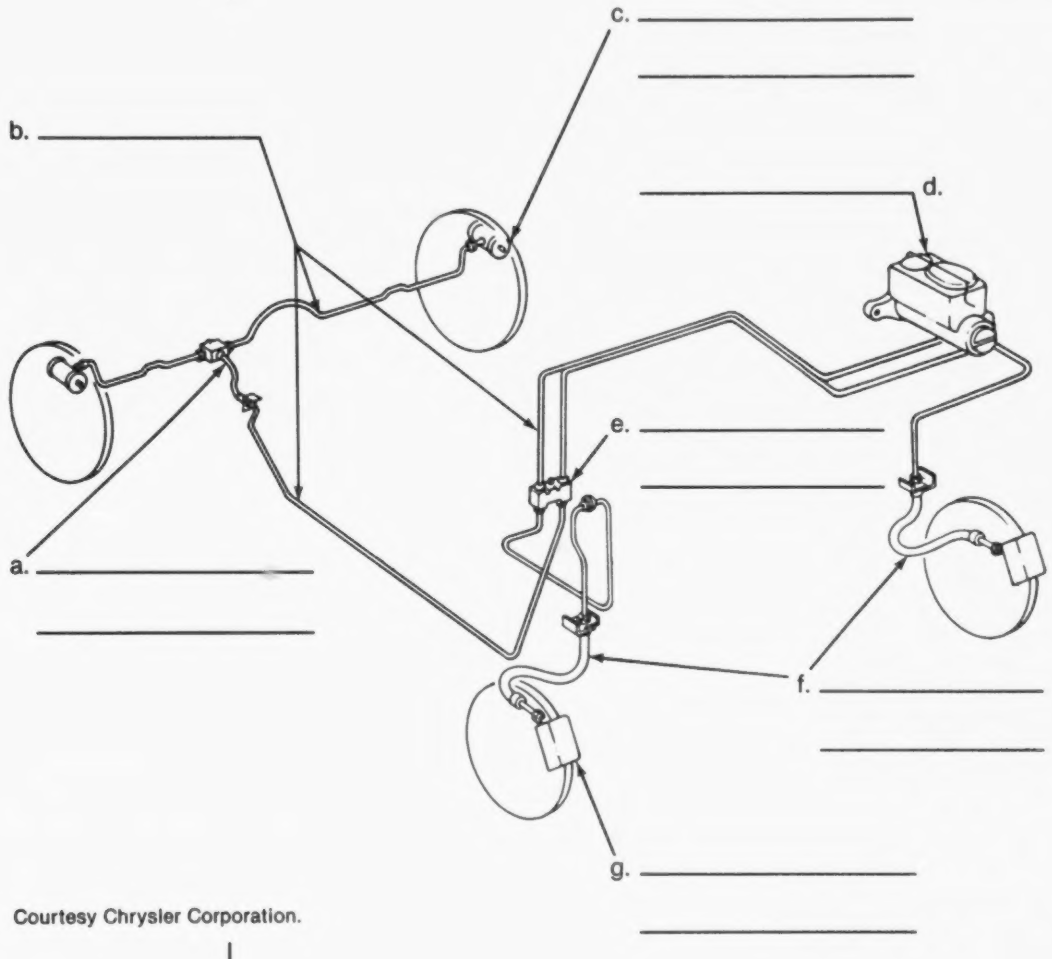
______m. **Recondition**

1. To machine or return a part to its original surface condition
2. To disassemble, clean, replace defective parts, and reassemble a component or assembly
3. To replace a component or assembly with one of the original diameter or state

_____n. **Vacuum power-assist unit**

1. Device that uses vacuum pressure supplied by accumulator to assist in applying brakes
2. Device that uses vacuum pressure supplied by intake manifold to assist in applying brakes
3. Device that uses vacuum pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

OBJECTIVE 2 Label the basic components of the hydraulic brake system illustrated below. Write the correct component names in the blanks.



Courtesy Chrysler Corporation.

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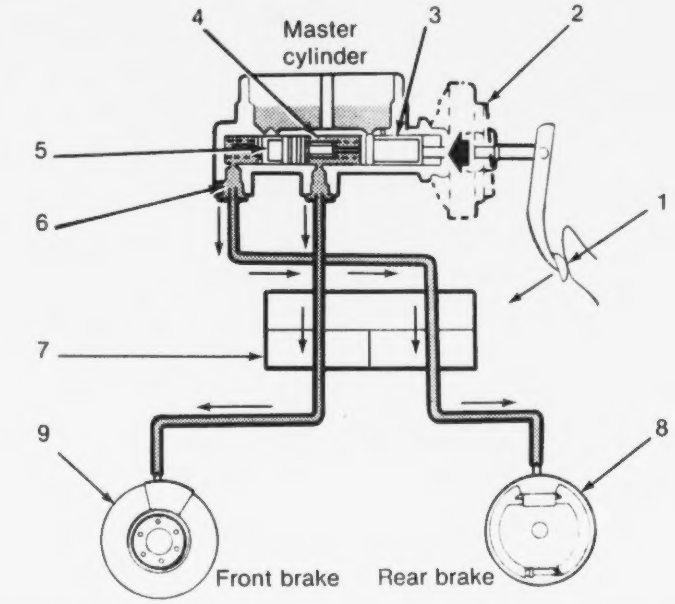
OBJECTIVE 3

List the steps in hydraulic brake operation in the order numbered on the illustration below.


4
Master cylinder
3
2
5
1
6
7
9
8
Front brake
Rear brake

From *Mitchell Automechanics*, copyright 1986. Used with permission of Ford Motor Company.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

7. ______________________________

____

8. ______________________________

____

9. ______________________________

____

OBJECTIVE 4

Write the characteristics of good brake fluid suggested by each of the following key-word items.

a. **Viscosity** — ______________________________

____

____

b. **Boiling point** — ______________________________

____

____

c. **Corrosion** — ______________________________

____

____

d. **Water tolerance** — ______________________________

____

____

e. **Lubricating ability** — ______________________________

____

____

f. **Freezing point** — ______________________________

____

____

OBJECTIVE 5

Select from the following list guidelines for handling and storing brake fluid. Write an "X" in the blank before each correct guideline.

_____a. Change brake fluid every 5000 miles, taking care **not** to spill fluid on any chrome or painted surface as it will damage these surfaces

_____b. Always keep brake fluid clean; do **not** allow any foreign material or petroleum product (gasoline, kerosene, oil, grease) to get into the fluid

_____c. Always use an empty oil can to store fluid, as the oil acts to lubricate the lines

_____d. Always clean off top of fluid reservoir before refilling it in order to avoid contamination of brake fluid

_____e. Use largest possible can of brake fluid to fill master cylinder; use half a large can rather than two small cans

_____f. Loosely cap fluid container after use to allow gases to escape and to prevent explosion

_____g. Keep master cylinder tightly covered, and reinstall cover immediately after filling master cylinder with new fluid

_____h. Keep fluid reservoir in pressure brake bleeder loosely capped except when refilling

_____i. Store brake fluid away from heat or flame, as it is highly flammable

OBJECTIVE 6

Complete the following statements describing hydraulic lines and fittings. Write the correct word or words in the blanks.

a. **Tubing** — Hollow brake line of _____________ _____________ coated to resist rust and corrosion and _____________ _____________ at both ends to accept male fittings

b. **Hose** — Hollow brake line of alternating layers of flexible _____________ and _____________ with threaded metal fittings at both ends

c. **Hose end fittings** — Threaded metal fittings designed to _____________ both inside and outside of hose; generally one end accepts a _____________ fitting and the other end accepts a _____________ fitting

d. **Double flare fitting** — Double lapped and flared steel tubing that is secured with a line or tube nut and requires a ______ ______

e. **International Standards Organization (ISO) flare fitting** — Flare design that requires no ______ ______ and cannot be ______ because shoulder of line or tube nut bottoms out in body of part, creating uniform pressure on flare

OBJECTIVE 7

Read the following service situations and then fill in the blank with the name of the tool that would be used.

a. You have removed, cleaned, and inspected the wheel bearings on a vehicle, and are now ready to pack new bearings before installing them. What tool would you use?

Tool — ______

b. You have just overhauled a master cylinder and have reinstalled it on the vehicle without first bench bleeding it. Now you are ready to reconnect the lines and bleed the hydraulic system. What tool would you use?

Tool — ______

c. You are pressure bleeding the front brakes on a vehicle, and you know that you must hold open the valve on the combination valve that delays front brake application because if you don't, you will introduce air into the rear brake system. What tool would you use to hold this valve open?

Tool — ______

d. You are replacing the brake lines on a vehicle. You have removed the old brake line, have measured it, and have obtained the replacement line. You need to shape the replacement line to the same configuration as the old line. What tool would you use?

Tool — ______

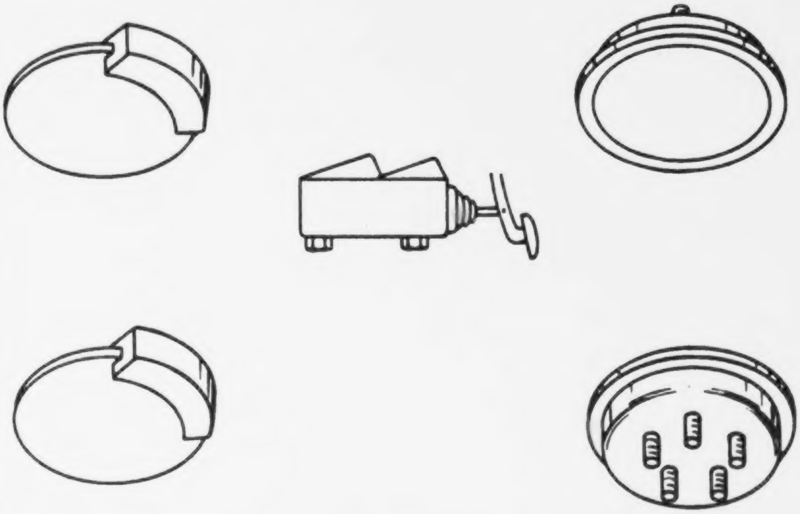
e. You are inspecting and checking a vacuum power-assist unit for proper operation and find that the check valve appears to be faulty. You want to test the engine vacuum supply. What tool would you use?

Tool — ______

OBJECTIVE 10

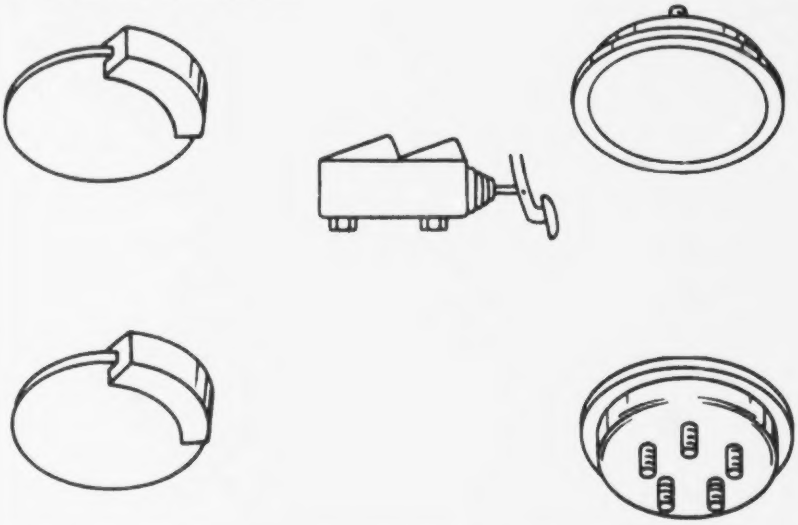
Complete the drawings of the hydraulic circuits for the dual braking system designs illustrated below.

Diagonally split system



Adapted with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985.*

Front-to-rear split system



Adapted with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985.*

OBJECTIVE 11

Evaluate each of the following case studies for asbestos safety violations. If no safety violation has been committed, leave the lines below the case study blank. If a violation has been committed, describe the safe procedure.

a. A brakes specialist is measuring and refinishing brake drums. She raises the vehicle and supports it properly on jack stands, removes the front wheel and drum, and properly places EPA-approved enclosure equipment over the hub assembly to form a tight seal.

b. After adjusting and reinstalling brake shoes and related hardware, a brakes specialist sweeps up the work area with a wet broom and disposes of the sweepings in the shop waste barrel.

c. A brakes specialist wears assigned protective clothing at all times during brake service. He removes his protective clothing in the shop at the end of the day, and the shop sees to it that the clothing is professionally laundered.

d. A brakes specialist orders a new set of brake pads from a reputable supplier. Because the pads are of current manufacture, the specialist assumes that they are made of nonasbestos friction material and that the brakes can be serviced without the use of an enclosure system.

e. A brakes specialist uses compressed air to clean a disc brake assembly of asbestos dust and then wipes the brake assembly with a dampened rag that is disposed of in a sealed plastic bag.

____

____

____

____

OBJECTIVE 12

Match the following terms associated with wheel bearings to their correct definitions. Write the correct numbers in the blanks.

_____a. To adjust bearings so that they will work under mild pressure

_____b. Thickness of a fluid; resistance to flow

_____c. Part of bearing that contains outer race; installed in hub with a press fit

_____d. Installation of a bearing cup with a tight or interference fit requiring more than hand pressure to install

_____e. Part that transmits a load to a support and thus absorbs most of the friction and wear of the moving part

_____f. Process of cleaning old grease from bearings and then forcing new wheel bearing grease into openings between races and ball or roller cages; may be done manually or mechanically

_____g. Installation of a bearing cone assembly with a light fit that can be installed with hand pressure

_____h. Part of roller bearing that contains inner race, roller cage, and rollers; installed on spindle with a push fit

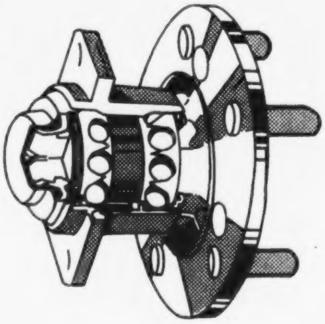
_____i. Surface or path on which bearing balls or rollers move

_____j. Amount of axial movement in hub due to clearance in bearings

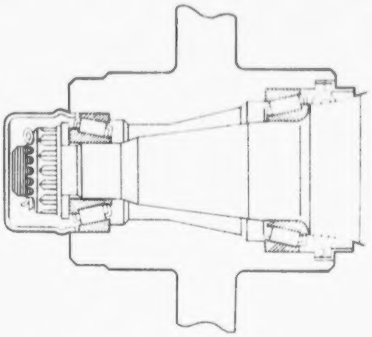
1. Viscosity
2. Preload
3. Press fit
4. Push fit
5. Bearing race (cup)
6. End play (bearing)
7. Bearing
8. Race
9. Bearing cone assembly
10. Packing

OBJECTIVE 13

Identify the following types of wheel bearings by writing the correct names in the blanks.

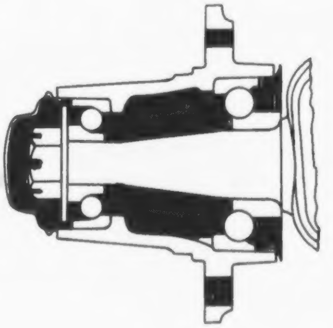


a. ____

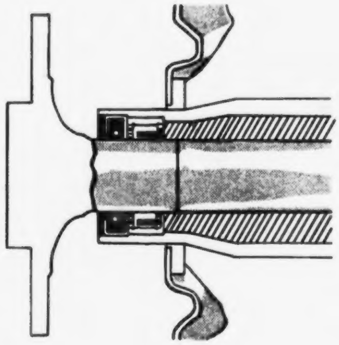


Used with permission of Chrysler Corporation.

b. ____



c. ____



d. ______________________________

OBJECTIVE 14

List the purposes of wheel bearings.

a. ______________________________

____

____

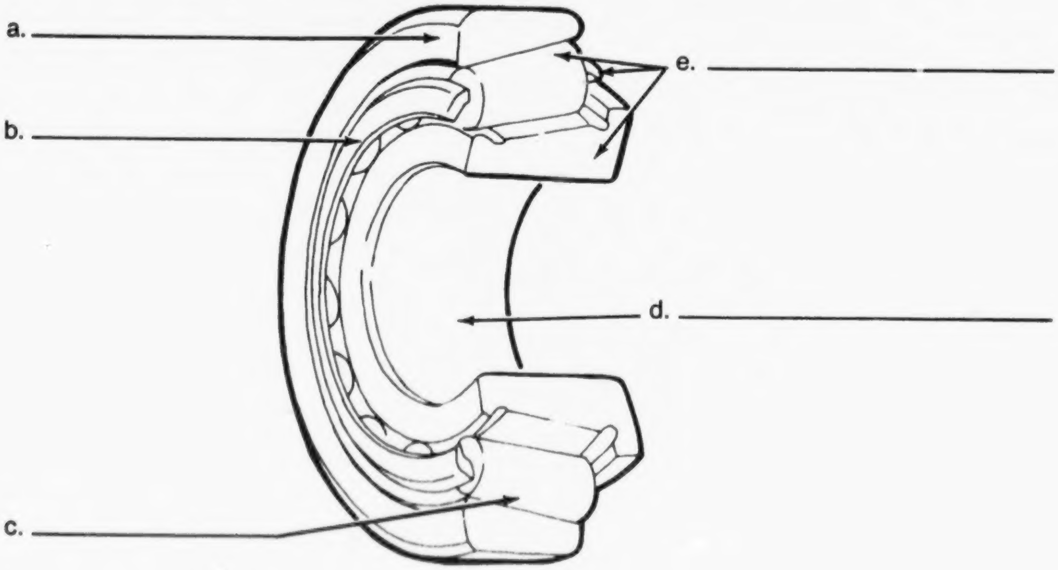
b. ______________________________

____

____

OBJECTIVE 15

Label the components of the tapered roller wheel bearing shown below. Write the correct names in the blanks.



OBJECTIVE 16

Select the properties of wheel bearing grease from the following list. Write an "X" in the blank before each correct statement.

_____a. Is water-soluble

_____b. Is heat-resistant

_____c. Adheres to friction surfaces

_____d. Is corrosive

_____e. Is able to form acids under adverse conditions

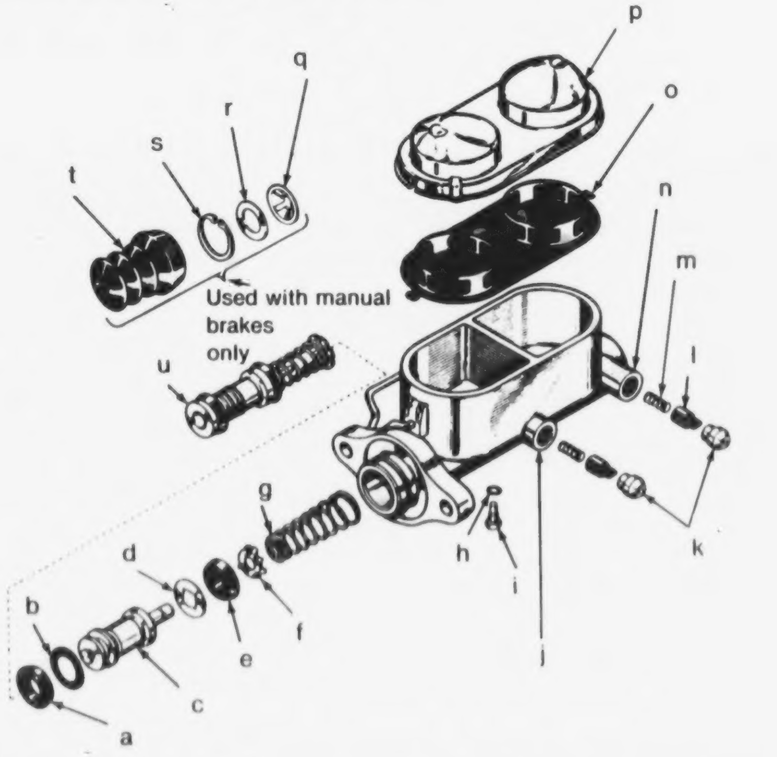
_____f. Is stable at high temperatures

_____g. Is water-resistant

_____h. Is noncorrosive

OBJECTIVE 20

Label the components of the typical dual master cylinder illustrated below. Use the blanks on the following page and write the correct names after the corresponding letters.



Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

k. ____________________

l. ____________________

m. ____________________

n. ____________________

o. ____________________

p. ____________________

q. ____________________

r. ____________________

s. ____________________

t. ____________________

u. ____________________

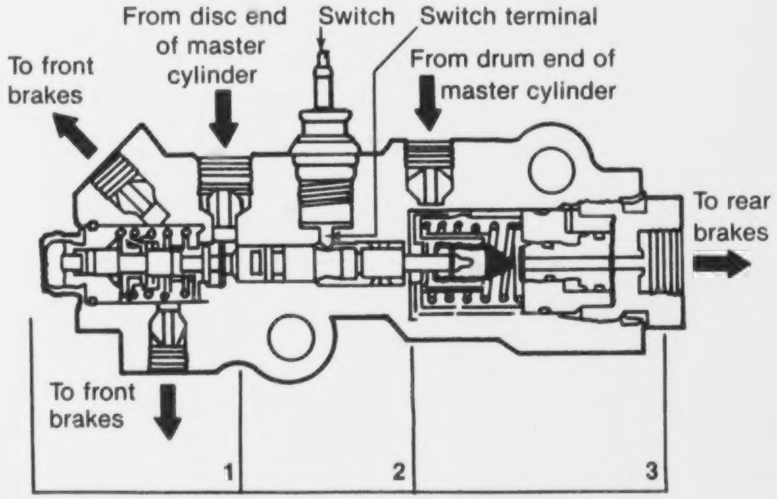
OBJECTIVE 25

Match the following combination valve components and functions to their correct counterparts on the illustration below. Write the correct numbers in the blanks.

_____a. **Pressure differential valve** — Turns on a warning light if the pressure drops in one part of the system

_____b. **Proportioning valve** — Reduces pressure to rear wheels during hard braking

_____c. **Metering valve** — Delays hydraulic pressure to front brakes until after rear brakes are applied



From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

OBJECTIVE 29

Diagnose brake system hydraulic and wheel bearing problems. Choose the statement below that best diagnoses each of the following problems. Write the correct numbers in the blanks.

_____a. A customer brings her automobile to your shop and complains that when she applies the brakes, the car seems to jerk or the brakes grab and she cannot come to a smooth stop. Which of the following would be the *most likely* cause?

1. Poor-quality brake fluid
2. Air in system
3. Swollen master cylinder cups
4. Rough or corroded master cylinder bore

______b. A customer complains that when he applies the brakes on his rear-wheel-drive vehicle, he hears a kind of chatter or scraping sound that does not change when he is accelerating, but decreases a bit when he lightly applies the brake. Which of the following would be the *most likely* cause?

1. Weak brake hoses that expand under pressure
2. Loose wheel bearings
3. Sticking wheel cylinder piston
4. Plugged master cylinder compensating ports

______c. A customer brings in a vehicle and complains that the car pulls to the left. You inspect the brake system and discover the cause to be a sticking caliper piston. Which of the following would be the proper corrective action?

1. Adjust hydraulic pressure at master cylinder
2. Replace caliper piston seal
3. Replace caliper
4. Adjust master cylinder pushrod

______d. You discover that clogged master cylinder tubes and hoses are the cause of a "hard pedal" in the vehicle you are servicing. Which of the following would be the proper corrective action?

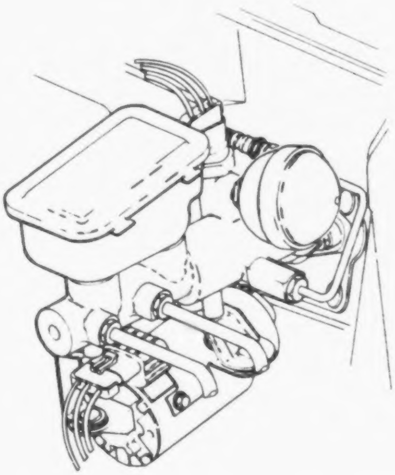
1. Blow out hoses and tubes with compressed air
2. Bleed hydraulic system
3. Flush hydraulic system
4. Replace tubes and hoses

______e. A customer brings in a vehicle and complains that the brakes seem to drag and the car will not roll freely. You check and find that the brake adjustment is correct. Which of the following would be the *most likely* cause?

1. Soft or swollen rubber parts caused by incorrect or contaminated brake fluid
2. Loose wheel bearings
3. Improperly adjusted master cylinder pushrod
4. Leak in hydraulic system

OBJECTIVE 30

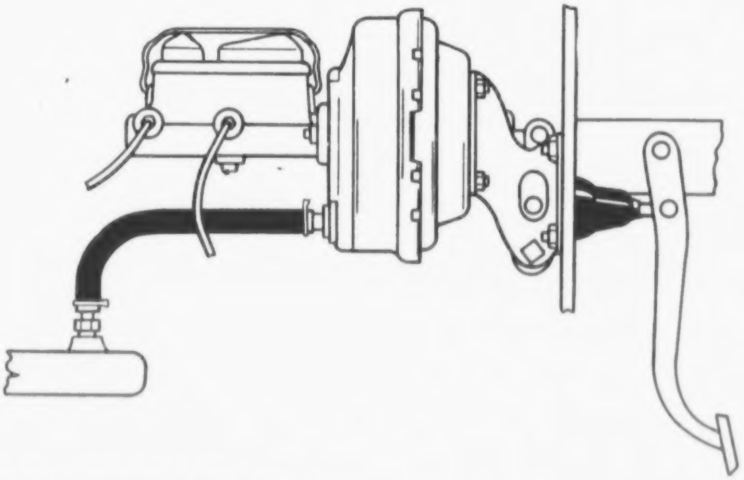
Write the correct names for the power-assist units illustrated below and on the following page.



Used with permission of General Motors Corporation, Delco Moraine Motor Division.

a. ____

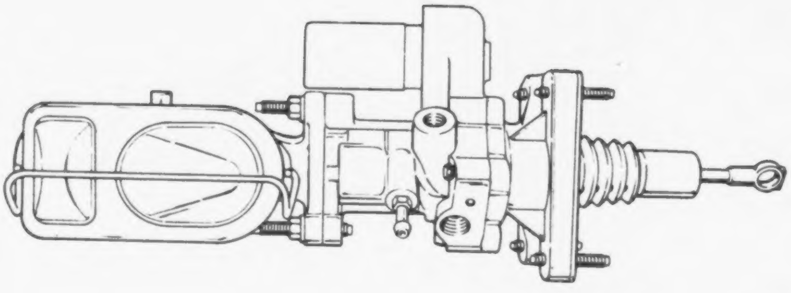
____



Used with permission of Allied Aftermarket.

b. ____

____

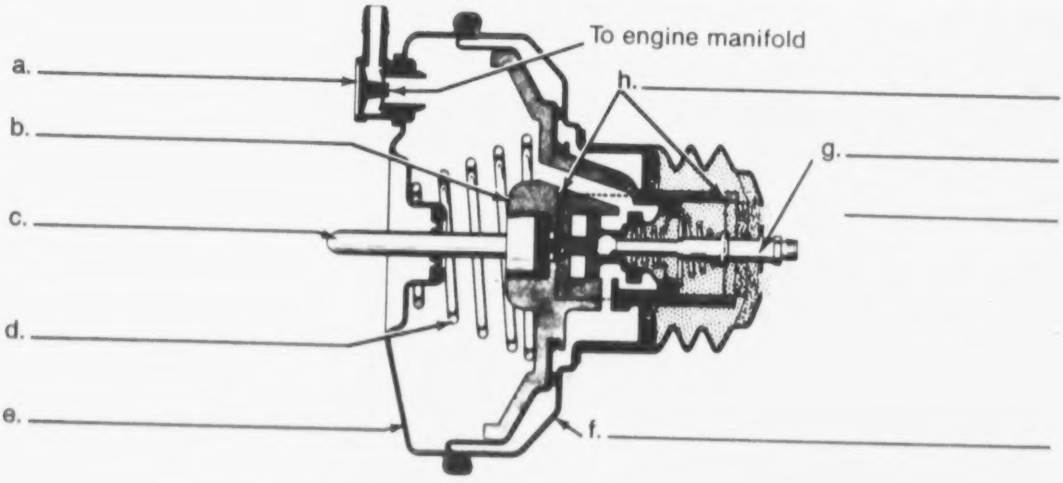


From *Automotive Chassis Systems: Steering, Suspension, Alignment, Brakes*, 2nd ed., copyright 1985. Used with permission of Ford Motor Company.

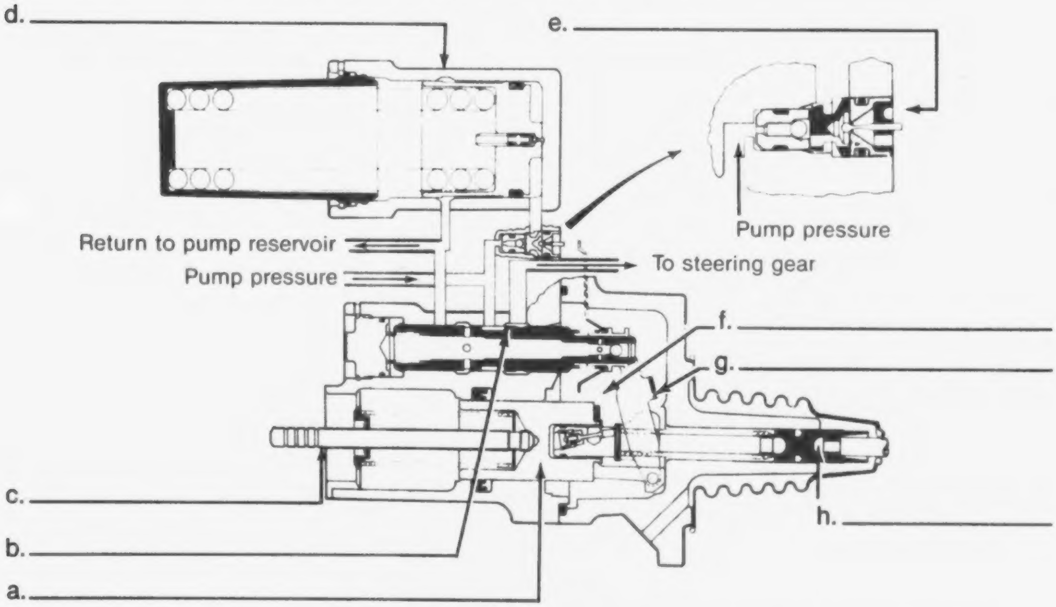
c. ______________________________

____

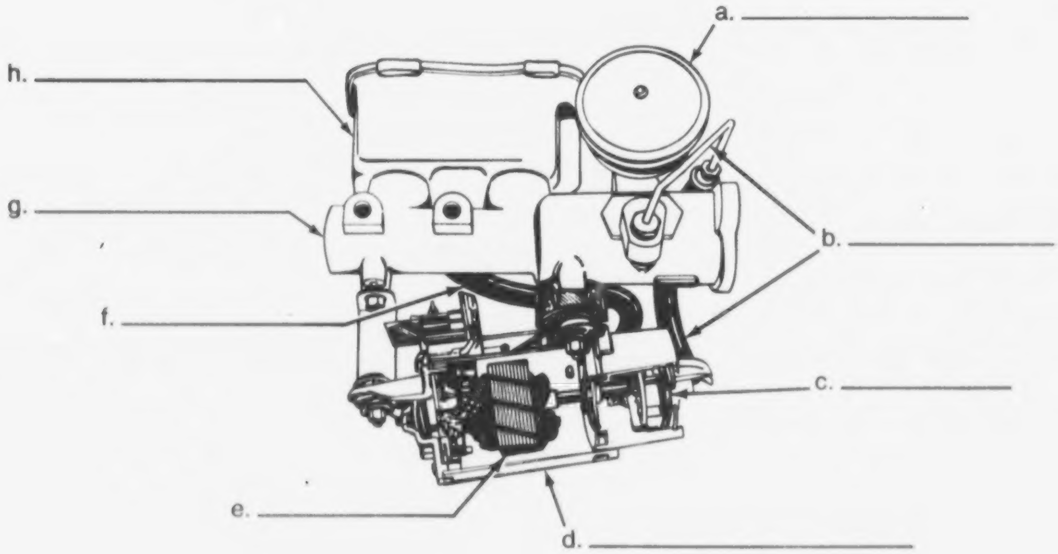
OBJECTIVE 31 Write the names of the components of the vacuum power-assist unit illustrated below.



OBJECTIVE 32 Write the names of the components of the hydraulic power-assist unit (mechanical pump) illustrated below.


d.
e.
Pump pressure
Return to pump reservoir
Pump pressure
To steering gear
f.
g.
c.
h.
b.
a.

OBJECTIVE 33 Write the names of the components of the hydraulic power-assist unit (electrical pump) illustrated below.



OBJECTIVE 34

Diagnose power-assist unit problems. Choose the statement below that best diagnoses each of the following power-assist unit problems. Write the correct numbers in the blanks.

_____a. You are servicing an automobile with a vacuum power-assist unit and find a faulty vacuum check valve. Which of the following would be the proper corrective action?

1. Repair valve according to manufacturer's specifications
2. Oil valve
3. Replace valve
4. Replace power-assist unit

_____b. A customer brings in an automobile equipped with a hydraulic power-assist unit with mechanical pump. She complains that it takes a lot of effort to depress the brake pedal and bring the vehicle to a stop. Which of the following is the *most likely* cause?

1. Clogged return line from booster to pump reservoir
2. Faulty booster input rod seal with leakage at input rod end
3. Spool return spring damaged
4. Internal leakage in accumulator

_____c. You are servicing a vehicle equipped with a hydraulic power-assist unit with electrical pump and find that the pump motor runs but does not shut off in 20 seconds. You inspect the system and determine that this problem is caused by higher-than-normal pump pressure. Which of the following would be the proper corrective action?

1. Replace switch
2. Replace pump
3. Replace accumulator
4. Replace power piston

_____d. A customer brings in a car with a hydraulic power-assist unit with electrical pump and complains that the warning light remains on after engine start. Which of the following would be the *most likely* cause?

1. Pump reservoir at FULL when accumulator is fully depressurized
2. Reservoir cover and diaphragm sealed too tightly
3. Accumulator precharge pressure at normal
4. Faulty warning light pressure switch

_____e. A customer brings in a vehicle with a vacuum power-assist unit and complains that the brakes seem to grab. Which of the following is the *most likely* cause?

1. Reaction diaphragm leakage
2. Plugged breather
3. Faulty vacuum check valve
4. Low fluid level

OBJECTIVE 39

Match the following antiskid system components to their correct functions. Write the correct numbers in the blanks.

_____a. Monitors system operation during normal driving as well as during antilock braking

_____b. Controls pressure in lock-up situations

_____c. Monitors wheel for lockup and transmits lock-up condition to controller

_____d. Activates light on dash if system malfunctions

1. Electronic controller
2. Antilock warning switch
3. Wheel sensor
4. Solenoid valve

NOTE: Turn in your test to your instructor, who will grade the test and determine whether additional training is needed.

WRITTEN TEST ANSWERS

SERVICE BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 1

a. 1
b. 2
c. 3
d. 1
e. 3
f. 2
g. 3
h. 2
i. 3
j. 3
k. 2
l. 1
m. 1
n. 2

OBJECTIVE 2

a. Rear brake hose
b. Brake lines
c. Rear wheel cylinder
d. Master cylinder
e. Combination valve
f. Front brake hose
g. Front brake caliper

OBJECTIVE 3

1. Brake pedal is depressed
2. Booster (if used) increases force into master cylinder
3. Pushrod forces primary piston forward
4. Fluid in primary cylinder is pressurized to apply front brakes
5. Pressure in primary cylinder pushes secondary piston forward
6. Secondary cylinder is pressurized to apply rear brakes
7. Brake valve is used to delay (meter) front brake application; proportion rear pressure to front pressure; and trigger warning system
8. Pistons in wheel cylinder push brake shoes against drum in drum-type brakes used on rear wheels
9. Piston(s) in caliper forces brake pad against rotor in disc-type brakes used on front wheels

OBJECTIVE 4

a. Should be free-flowing at all temperatures
b. Should have high boiling point so that it remains in liquid state at highest operating temperatures encountered
c. Should be noncorrosive so that it does not attack rubber or metal parts, and should act as an antirust agent
d. Should be able to absorb and retain moisture that collects in system
e. Should lubricate pistons and cups to reduce wear and internal friction
f. Should have low freezing point so that it remains fluid and flows at low ambient and operating temperatures

OBJECTIVE 5

b, d, g, i

OBJECTIVE 6

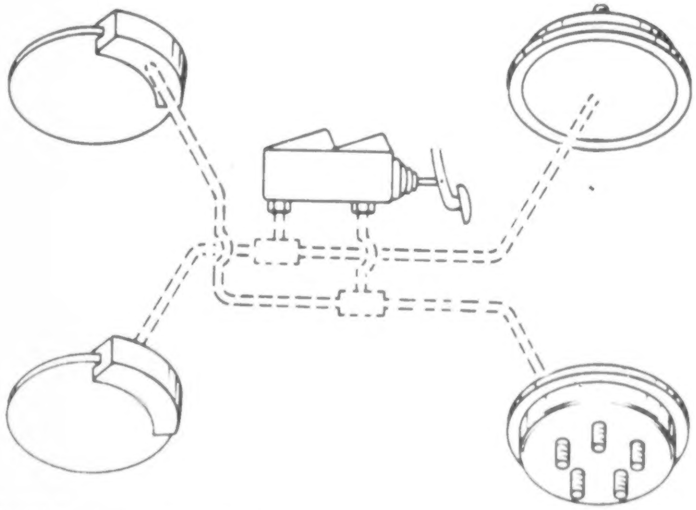
a. Bendable steel; double flared
b. Rubber; fabric
c. Grip; male; female
d. Tube seat
e. Tub seats; overtightened

OBJECTIVE 7

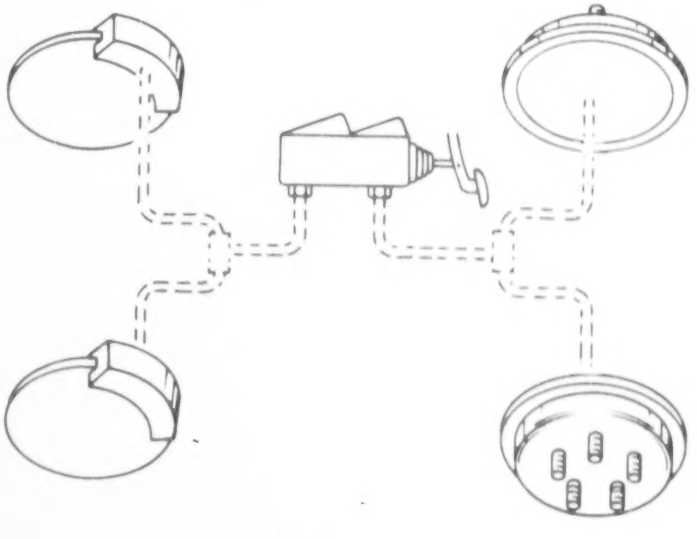
a. Wheel bearing packer
b. Brake pressure bleeder
c. Metering valve tool
d. Lever-type tubing bender
e. Pressure gauge

OBJECTIVE 10

Diagonally split system



Front-to-rear split system



OBJECTIVE 11

a. She must install the enclosure equipment before removing drum
b. The area where brake work is done should never be swept; a vacuum equipped with a HEPA filter must be used, and waste must be disposed of according to EPA's asbestos-disposal guidelines
c. No safety violation committed
d. While the manufacture of nonasbestos brake linings is increasing, unless the specialist is certain that the linings contain no asbestos, he or she should use an enclosure system
e. Compressed air should never be used without an enclosure system as it spreads asbestos particles; a damp rag does not prevent scattering of asbestos; an OSHA-approved enclosure cleaning system should be used

OBJECTIVE 12

a. 2
b. 1
c. 5
d. 3
e. 7
f. 10
g. 4
h. 9
i. 8
j. 6

OBJECTIVE 13

a. Integrated ball bearings (sealed bearings)
b. Tapered roller bearings
c. Ball bearings
d. Straight roller bearing

OBJECTIVE 14

a. To reduce friction between revolving wheel hub and spindle
b. To spread vehicle loads over a larger surface area

OBJECTIVE 15

a. Outer race (cup)
b. Cage
c. Roller
d. Inner race
e. Cone assembly

OBJECTIVE 16

b, c, f, g, h

OBJECTIVE 20

a. Secondary cup
b. O ring
c. Secondary piston
d. Cup washer
e. Primary cup
f. Cup protector
g. Return spring
h. O ring
i. Piston stop bolt
j. Rear brake outlet
k. Tube seats
l. Residual pressure check valve
m. Check valve spring
n. Front brake outlet
o. Diaphragm
p. Cover
q. Pushrod retainer
r. Retainer
s. Snap ring
t. Boot
u. Primary piston

OBJECTIVE 25

a. 2
b. 3
c. 1

OBJECTIVE 29

a. 4
b. 2
c. 3
d. 4
e. 1

OBJECTIVE 30

a. Hydraulic power-assist unit with electrical pump
b. Vacuum power-assist unit
c. Hydraulic power-assist unit with mechanical pump

OBJECTIVE 31

a. Vacuum check valve
b. Power piston
c. Master cylinder pushrod
d. Power piston return spring
e. Rear housing
f. Front housing
g. Brake pedal pushrod
h. Floating control valve

OBJECTIVE 32

a. Booster piston
b. Control valve
c. Output rod
d. Accumulator
e. Accumulator control valve
f. Booster pressure chamber
g. Control valve reaction lever
h. Input rod

OBJECTIVE 33

a. Accumulator
b. Supply hose
c. Pump
d. Pump and motor housing
e. Electric motor
f. Return hose
g. Master cylinder body
h. Master cylinder reservoir

OBJECTIVE 34

a. 3
b. 2
c. 1
d. 4
e. 1

OBJECTIVE 39

a. 1
b. 4
c. 3
d. 2

OBJECTIVE SHEET

UNIT 2 SERVICE DRUM BRAKES

INTRODUCTION

All four wheels on an automobile are brake units that stop the car by changing motion to heat. For many years, drum brakes were used on all four wheels. Today, drum brakes have been almost totally replaced at the front wheels by disc brakes. However, drum brakes are still used at the rear wheels of most new American automobiles. Small drum parking brakes are also used in the rear wheel rotors of some four-wheel disc brake systems.

UNIT OBJECTIVE

After completing this unit, the student should be able to diagnose drum brake problems and service drum brake systems. The student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

PREREQUISITES

Before studying this unit the student should have successfully completed Unit 1, "Service Brake Hydraulic System and Wheel Bearings."

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to

1. Recognize definitions of terms associated with drum brakes by choosing the correct definitions from lists of three choices.
2. Recall uses of specialty tools used to service drum brakes by writing the correct use when given the name of a specialty tool.
3. Recall steps in drum brake operation by listing the steps in correct sequence.

4. Recall components of typical duo-servo and non-servo brake assemblies by labeling the components shown on an illustration.

5. Recognize the functions of components of a duo-servo brake assembly by matching components to their correct functions.

6. Recognize definitions of terms associated with brake drum problems by matching terms to their correct definitions.

7. Recall defects to look for when visually inspecting drum brake components by listing defects for given component names.

8. Remove, clean, and visually inspect brake drums. (Job Sheet 1)

9. Measure and refinish brake drums. (Job Sheet 2)

10. Recall common types of brake shoe mountings by writing the correct names for given illustrations.

11. Remove, clean, and inspect brake shoes and related hardware. (Job Sheet 3)

12. Recall basic components of a typical wheel cylinder by writing the names of components shown on an illustration.

13. Recall types of wheel cylinders used with drum brakes by writing the correct names for given illustrations.

14. Remove, recondition, and reinstall a wheel cylinder. (Job Sheet 4)

15. Recognize types of automatic drum brake shoe adjusters by labeling illustrations with the correct names.

16. Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies. (Job Sheet 5)

17. Adjust an integral parking brake. (Job Sheet 6)

18. Diagnose drum brake problems. (Assignment Sheet 1)

SUGGESTED ACTIVITIES

SERVICE DRUM BRAKES

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section. Include in your selection media that demonstrate job-sheet skills. Videotape your own demonstrations of job-sheet procedures if unable to obtain suitable media.

- Obtain transparencies and competency profiles for this unit. See ordering information in the "Suggested Resources" section.

- Prepare classroom and shop. Display posters, charts, safety signs, etc., related to drum brake service. Have articles, specification guides, mock-ups, component displays, and other drum brake service resource material available for student reference. Display various types of brake drums, brake adjusters, and related hardware.

- Discuss with students the purpose of pretesting. Explain that they will be asked to complete a written pretest and that they will be required to demonstrate assignment-sheet competencies and job-sheet skills as part of the pretesting process.

- Provide students with equipment and materials necessary to complete pretest. Administer pretest.

- Assess student competencies. Consider results of student assessments of the unit objectives as you prepare your presentation for each objective.

DELIVERY

Unit introduction

- Discuss introduction to the unit (see "Objective Sheet").

- Discuss the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives will lead to meeting the unit objective and how reaching the unit objective is vital to becoming an automotive brakes specialist. Also relate the objectives to your introduction and to materials previously covered.

- Provide students with the Raybestos *Pit Stop for a Brake Clinic* brochure, and show the film that comes with this kit. After the film, give the students the quiz, explaining that the quiz is patterned after the brake portion of the NIASE Mechanic Certification Test. Discuss quiz questions and answers with the class.

- Use Transparency 1, "Components of the Tandem or Dual Brake System," to introduce students to the typical components of this brake system with rear drum and front disc brakes.

- Review asbestos safety, stressing the absolute necessity for avoiding inhalation of asbestos particles.

- Tour the shop, pointing out equipment and materials involved in servicing drum brakes.

Objective 1 Recognize definitions of terms associated with drum brakes

- Point out examples of appropriate terms in the shop, and make examples available in the classroom.

- Show samples of various types of drum brakes.

- Show students the primary and secondary shoes (forward or reverse shoes on non-servo brakes) on servo and non-servo drum brakes. Point out the differences in lining length and position. Discuss the reasons for these differences.

- Show students a labyrinth seal to illustrate that term and the term *flange*.

- Show students the pawl on a drum brake adjuster.

- Demonstrate honing.

- Show students the location of the residual valve on a vehicle, and discuss its function.

- Discuss the terms *self-energizing* and *servo action*.

Objective 2 Recall uses of specialty tools used to service drum brakes

- Show students an example of each of the tools listed in this objective, and demonstrate the use of each tool, allowing each student to return the demonstration.

- Where applicable, show students alternative tools that may be used to accomplish a task.

  EXAMPLE: Using a screwdriver or welding rod with a brake spoon

- Discuss the care and maintenance of each tool and show students the proper shop storage location for each of the tools. Stress the need for returning tools to proper storage.

- Show students the enclosure-type brake cleaner, stressing the importance of protection from asbestos particles, but reserve your demonstration for Objective 8 (Job Sheet 1). Do the same with the drum brake lathe, reserving your demonstration for Objective 9 (Job Sheet 2).

- Point out that the enclosure-type cleaner is included as a specialty tool used with drum brakes, but that it must be used with disc brakes as well, to protect the technician from harmful asbestos particles.

- Show students brake adjusting spoons for different makes and models of automobiles. Demonstrate various designs, explaining the reasons for these design variations.

- Allow students to practice using the brake drum micrometer and drum-to-shoe gauge until they are proficient.

- Have students complete Activity Sheet 1, "Determine Correct Specialty Tools to Use to Service Drum Brakes."

Objective 3 Recall steps in drum brake operation

- Discuss braking action in general, reviewing hydraulic principles and friction.

- Use media presentation, *Brakes: Principles and Components*, to expand on the basic principles outlined in this objective. Hold a question-and-answer session after viewing media presentation.

- Demonstrate centrifugal force and the natural inclination of an object to move in the direction of rotation. Set up a record player, tape a cardboard rim around an old record, and place the record on the turntable. Then place a checker near the center of the record, adjust record player to slowest speed, and turn on the player. The checker will move to the outer rim of the record and will move in the direction of rotation. Explain that hydraulic pressure, rather than centrifugal pressure, pushes brake shoes against the rotating drum, but the shoes then try to rotate with the drum like the checker. This self-energizing action supplements hydraulic pressure.

- Discuss Figure 15.

Objective 4 Recall components of typical duo-servo and non-servo brake assemblies

- Combine this objective with Objective 5, explaining the function of each component of the duo-servo assembly as you name each of the parts.

- Show students examples of various duo-servo and non-servo brake assemblies. Point out and explain the reasons for design differences.

- Provide students with copies of Supplement 3, "Types of Import Drum Brakes," for future reference.

- Display the *Lee Import Drum Brake Assemblies* wall chart. Discuss the chart in conjunction with Supplement 3 illustrations.

- Provide students with the Bendix *Brake System Schematic*, or display the schematic in the classroom or shop.

- Pair students and have each team quiz each other on the names and locations of the components of duo-servo and non-servo brake assemblies.

Objective 5 Recognize the functions of components of a duo-servo brake assembly

- Explain the differences between duo-servo and non-servo brake function. Use the box material, "Servo Action," to assist you in your explanation.

- Using a duo-servo brake assembly that has been removed from a vehicle, explain the function of each component as you name each of the parts.

- Pair students and have each team quiz each other on the functions of the components of a duo-servo brake assembly.

- Explain that *duo* means "two" and thus that duo-servo action indicates that servo action is supplied in both forward and reverse directions.

Objective 6 Recognize definitions of terms associated with brake drum problems

- Show students examples of defective drums or drum brake hardware to illustrate each of the terms listed.

- Collect defective drums or drum brake hardware illustrating each of the problems listed, and display these components on a table. Number each with a three-by-five card, and have students identify and write down the correct term for each problem displayed.

- Have students complete Supplement 1, "Drum Brake Crossword Puzzle," to review these terms and those terms in Objective 1.

Objective 7 Recall defects to look for when visually inspecting drum brake components

- Pair students and have each team perform a visual inspection of drum brake components on a live automobile. Have students use Table 1 in this objective as a checklist, each team checking those items that they find defective.

- Demonstrate a visual inspection of an automobile brake system, pointing out any drum brake component defects found. Explain the different conditions or symptoms caused by these defects.

- Show students examples of each of the defects listed in this objective, display drums with each of the defects listed in Student Supplement 2, "Causes of Drum Brake Defects," and discuss in class.

- Provide students with copies of *Drum Brake Service Manual* (17D-11) and the Abex Corporation booklet, *Looking Inside the Brake Drum*, to use as supplemental references.

- Review asbestos safety guidelines. Introduce students to the installation and use of the enclosure-type cleaner. Make sure that each student knows how to install and use this equipment.

- Show media presentations, "Remove, Inspect, and Replace Brake Drums," *Drum Brake Service* or *GM X-Body Brake Service*.

- Discuss the correct use of an inspection report form such as Supplement 4, "Brake System Inspection Report Form," or similar form, and provide students with copies for them to use while practicing inspection procedures.

- Discuss equipment and materials used in Job Sheet 1, "Remove, Clean, and Visually Inspect Brake Drums." Review with students applicable safety rules and precautions, and discuss the job-sheet introduction.

- Demonstrate Job Sheet 1.

- Introduce students to the drum brake lathe and its accessories. Explain how the lathe can be adapted for grinding and for disc brake machining. Have each student practice mounting a drum on the lathe and adjusting it for correct grinding or machining procedures.

- Show media presentation, such as *The Brake Lathe*, "Resurfacing a Brake Drum," or *Drum Lathe Operation* to supplement your introduction of the drum brake lathe.

- Discuss equipment and materials used in Job Sheet 2, "Measure and Refinish Brake Drums." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 2.

- Have students practice Job Sheets 1 and 2, having them continue to Job Sheet 2 upon completion of Job Sheet 1, until they are ready to take the practical test.

Objective 10 Recall common types of brake shoe mountings

- Show students examples of each type of mounting.

- Use Transparency 2, "Parts of a Typical Drum Brake Shoe," when discussing brake shoe mountings.

- Exhibit the two types of mountings and have students identify each.

- Explain the relationship between mounting types and servo or non-servo action.

- Discuss the advantages of one type over another.

- Discuss information presented in Supplement 2, "Characteristics of Good Brake Linings."

- Show media presentation, "Remove and Replace Brake Shoes."

- Discuss equipment and materials used in Job Sheet 3, "Remove, Clean, and Inspect Brake Shoes and Related Hardware." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction.

- Demonstrate Job Sheet 3. Have students practice Job Sheet 3 until they are ready to take the practical test.

Objective 12 Recall basic components of a typical wheel cylinder

- Show students the location of the wheel cylinders on various makes and models of vehicles.

- Remove a double-piston straight-bore wheel cylinder from a vehicle and disassemble it, naming and noting the location of each component as it is disassembled.

- Review the hydraulic principles used to activate wheel cylinders as explained in the box material, "Wheel Cylinder Operation."

- Pair students and provide each team with a wheel cylinder. Have the teams quiz each other on the locations and names of the components.

Objective 13 Recall types of wheel cylinders used with drum brakes

- Show students examples of each of the types of wheel cylinders used with drum brakes.

- Discuss box material, "Design Variations." Also discuss fixed, floating, and sliding single-piston wheel cylinders.

- Exhibit the different types of wheel cylinders, and have students identify each different type.

- Point out that normally front-engine passenger cars equipped with drum brakes use a larger-diameter wheel cylinder on the front axle brakes, and explain why.

- Show students a wheel cylinder with a baffle. Explain that this type of wheel cylinder is used on smaller-diameter forward front brakes to eliminate the clunking noise heard when the direction of braking is changed from forward to reverse or from reverse to forward. Explain that a baffled wheel cylinder should not be reconditioned with a cylinder hone because the baffle prevents uniform honing and may leave burrs on the cylinder bore or the baffle, which could affect the safe operation of the wheel cylinder. Baffled cylinders should be replaced as a unit.

- Show students an aluminum wheel cylinder and explain that aluminum wheel cylinders should not be honed if pitted or corroded. This type of wheel cylinder should be replaced as a unit.

- Explain to the students the use of the expander in the wheel cylinder and that this device is used on many vehicles in place of the residual valve in the master cylinder. This device keeps the cup seal lip snug against the cylinder bore to prevent leakage of air into the cylinder.

- Explain that on many vehicles the wheel cylinders can be disassembled without removing the cylinder from the backing plate. Explain also that on some brakes the cylinder is mounted in an indentation in the backing plate and the piston stop is welded to the plate, necessitating removal before disassembly. Show students examples of each type of mounting.

- Recommend that students always use a wheel cylinder repair kit to recondition a wheel cylinder, that they dip the piston cups in clean brake fluid and coat the cylinder bore with clean brake fluid before assembly, and that they avoid handling any of the parts with greasy or oily hands as this could damage the rubber parts.

- Show media presentation, "Remove, Repair, and Replace Wheel Cylinders."

- Discuss equipment and materials used in Job Sheet 4, "Remove, Recondition, and Reinstall a Wheel Cylinder." Review with students applicable safety rules and precautions, and discuss the job-sheet introduction.

- Demonstrate Job Sheet 4. Have students practice Job Sheet 4 until they are ready to take the practical test.

Objective 15 Recognize types of automatic drum brake shoe adjusters

- Show students examples of manual and automatic adjusters.

- Display all types of automatic adjusting assemblies and have students identify each.

- Explain that some automatic adjustment systems operate only when braking in reverse; others when braking in a forward direction; others when using the parking brake, and still others when braking in either forward or reverse. If the actuating cable or link is attached to the anchor, adjustment takes place when braking in one direction only. If the actuating cable or link is attached to the brake shoe, adjustment takes place when braking in either direction.

- Illustrate your discussion of brake shoe adjusters with Transparencies 3 through 5 and with Supplement 3, "Types of Import Drum Brakes," as applicable.

- Make it clear to the students that there are so many different types of adjusters and so many different ways to make manual and automatic brake adjustments that the specialist must *always* follow procedures outlined in the service manual for the make and model vehicle being serviced.

- Show students how adjuster components on some models are color coded.

- Caution students about interchanging parts from one side of the vehicle to the other or attempting to convert an old-style star wheel or adjuster. As an example, explain that some star-wheel adjusters on the right side of the vehicle may have right-hand threads and those on the left side may have left-hand threads. Interchanging these adjusters would cause the automatic adjusting levers to back off on the assemblies every time a stop was made in reverse, resulting in low brake pedal reserve.

- Show media presentations, "Adjust Brake Shoes," "Removing Drum-Type Brake Linings," and "Installing Drum-Type Brake Linings."

- Discuss equipment and materials used in Job Sheet 5, "Adjust Brake Shoes and Reinstall Shoes, Related Hardware, and Drums or Drum/Hub Assemblies," and Job Sheet 6, "Adjust an Integral Parking Brake." Review applicable safety rules and precautions and the guidelines given in the job-sheet introductions.

- Demonstrate Job Sheet 5 and Job Sheet 6. Have students practice Job Sheets 5 and 6 until they are ready to take the practical tests.

- Have students complete Assignment Sheet 1, "Diagnose Drum Brake Problems."

Unit summary activity

- Discuss Activity Sheet 2, "Answer General Questions About Drum Brakes." The purpose of the activity is to provide students with the opportunity to practice answering questions similar in content and style to those found on the actual ASE certification test. Keep this in mind when discussing the assignment.

- Have students complete Activity Sheet 2.

EVALUATION

- Give written test.
- Give practical tests, providing students with copies of Supplement 4, "Brake System Inspection Report Form," or similar form to be completed as part of the practical tests. Evaluate tests on forms provided.
- Reteach and retest as required.
- Complete appropriate section of competency profiles.

SUGGESTED RESOURCES

Resources used in developing unit

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual*. Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.
- *Introduction to Automotive Mechanics, Unit 2: Lubrication, Cooling, and Safety Inspection Services*. Tallahassee, Florida: Florida Department of Education, 1986.
- Billiet, Walter E., and Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.
- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985*. Radnor, Pennsylvania: Chilton Book Company, 1984.
- Coghlan, David A. *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed. Boston: Breton Publishers, A Division of Wadsworth, Inc., 1985.
- Crouse, William H., and Donald L. Anglin. *Automotive Mechanics*, 9th ed. New York: Gregg Division, McGraw-Hill Book Company, 1985.
- Henderson, Chuck, and Ivan Armstrong. *Auto Mechanics I*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

- Hughes, James G. *Guide to Automobile Certification Examination*, Revised ed. Reston, Virginia: Reston Publishing Company, Inc., a Prentice-Hall Company, 1983.

- *Mitchell Chassis Service & Repair Domestic Cars: 1985 Supplement*. San Diego, California: Mitchell Information Services, Inc., a Cordura Company, 1985.

- *1986 New Model Highlights and Service Features: Domestic and Import*. Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1985.

- *1986 Chrysler Engine-Chassis-Body Service Manual: 1986 Front Wheel Drive Passenger Vehicles Lancer, Daytona, New Yorker, Dodge 600, Aries, Omni, LeBaron GTS, LeBaron, Caravelle, Reliant, Horizon*. Centerline, Michigan: Chrysler Corporation, 1985.

- *1986 Shop Manual: Caprice, Monte Carlo, El Camino*. Detroit, Michigan: General Motors Corporation, Chevrolet Motor Division, 1986.

- *Raybestos Brake Service Manual for Passenger Cars: Drum and Disc Brakes*. Bridgeport, Connecticut: Division of Raybestos Manhattan, 1970.

- Remling, John. *Brakes*, 2nd ed. New York: John Wiley and Sons, Inc., 1978.

- Stockel, Martin W., and Martin T. Stockel. *Auto Mechanics Fundamentals*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1982.

- Toboldt, William K., and Larry Johnson. *Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1983.

- *Wagner Manual AU-1600/Feb., 1984: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual*. Parsippany, New Jersey: Wagner Division, McGraw-Edison Company, 1984.

- *Wagner Manual AU-1600: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual*. Parsippany, New Jersey: Wagner Division, Cooper Industries, Inc., 1988.

Media

- *The Hydraulic Brake System Explained*. This series of six VHS cassettes (7 to 14 minutes each) and study guide contains a video on "How to Reline Drum-Type Brakes" and one titled "Servicing the Hydraulic System—Drum Type." It is available from National Innovative Media Company (NIMCO), Route #2, Box 301 B, Calhoun, Kentucky 42327, phone toll-free 800-962-6662.

- *Hydraulic Brake Service*. This series of six sound filmstrips contains filmstrips on "Removing Drum-Type Brake Linings" and "Installing Drum-Type Brake Linings."

- *The Brake Lathe*. This program of sound filmstrips includes a filmstrip on "Resurfacing a Brake Drum."

- *Brakes: Principles and Components*. This series of sound filmstrips and slides includes media on drum brakes and wheel cylinders.

- *GM X-Body Brake Service*. In this series, the Chevrolet Citation is used to introduce students to drum brake removal and reassembly.

NOTE: These first five items are available from Vocational Media Associates, Prentice Hall Media, P.O. Box 1050, Mount Kisco, New York 10549-9989. phone toll-tree 800-431-2266. All of these media are availble in their entirety for a full 30-day preview with no obligation.

- *Drum Brake Service*. Color filmstrip and cassette, available from Career Aids, Incorporated, 20417 Nordhoff Street, Department R., Chatsworth, California 91311, phone 818-341-8200.

- *Drum Brake Service* and *Drum Lathe Operation*. These two filmstrips and cassettes are available from Teaching Aids Incorporated, P.O. Box 1798, Costa Mesa, California 92628-0798, phone 714-548-9321.

- *Service Drum Brakes* containing the following: "Remove, Inspect, and Replace Brake Drums"; "Remove and Replace Brake Shoes"; "Remove, Repair, and Replace Wheel Cylinders"; and "Adjust Brake Shoes." These videotapes cover procedures outlined in the job sheets. Available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

Print Media

- *Looking Inside the Brake Drum*. Booklet covering numerous subjects, including lining installation, inspection of brake hardware, drum machining, and lining performance. Available free from Abex Corporation, Friction Products Division, 3001 West Big Beaver Road, Suite 710, Troy, Michigan 48084.

- *Drum Brake Service Manual (17D-11)*. Available free upon request from AC-Delco, General Motors Corporation, 400 Renaissance Center, Detroit, Michigan 48243.

- *Technical Bulletins*. Troubleshooting tips for current brake system and new brake system designs. Bulletins cover both domestic and import vehicles. Available from Autoline, 840 West 31st Street, Chicago, Illinois 60608.

- *Brake System Schematic*. Available from Bendix Automotive Aftermarket, 1094 Bendix Drive, Jackson, Tennessee 38301.

- *Lee Import Drum Brake Assemblies Wall Chart*. This 18" × 23" chart is available from Lee Manufacturing Company, Division of Rolero, Inc., 4933 East 15th Street, Cleveland, Ohio 44128.

- Raybestos *Pit Stop for a Brake Clinic*. This booklet and film (Form #3815—Complete Kit) comprise a vocational school training program consisting of films, brochures, and a quiz patterned after the brake portion of the ASE Mechanic Certification Test. Available from Raymark Corporation, Aftermarket Division, 100 Overview Drive, Trumbull, Connecticut 06611.

- Transparencies and competency profiles

  NOTE: Transparencies and competency profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

INSTRUCTOR'S SUPPLEMENTS

SERVICE DRUM BRAKES

SUPPLEMENT 1

Drum Brake Crossword Puzzle

Use your knowledge of the drum braking system and the clues below to complete the crossword puzzle on the next page.

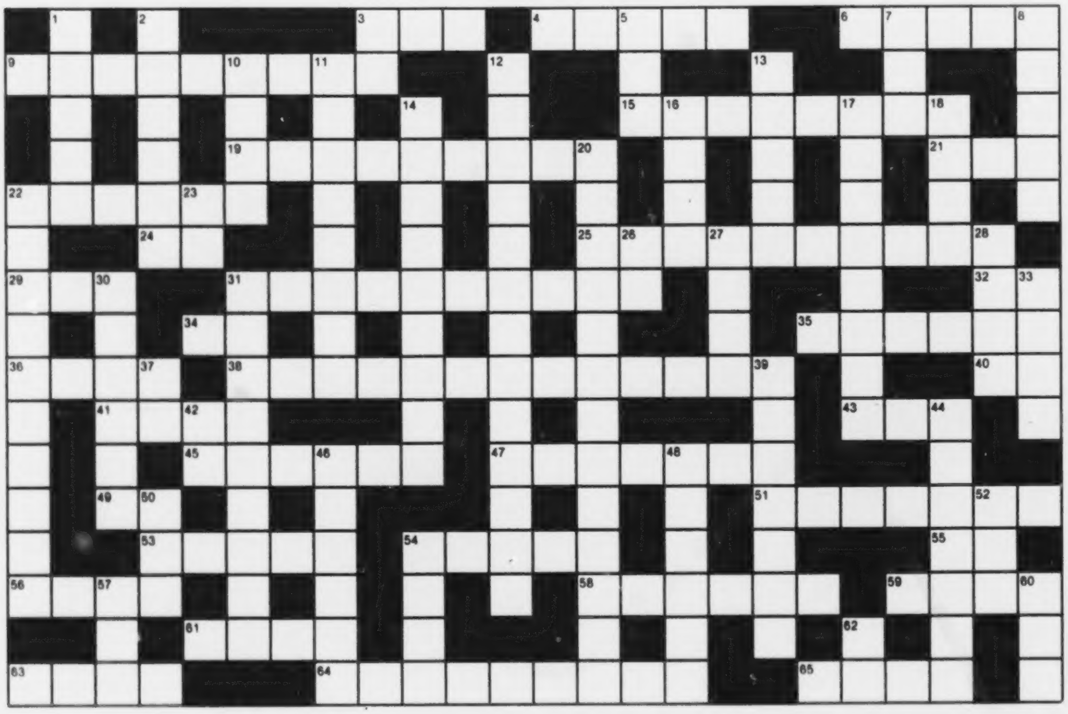
ACROSS

3. In the middle
4. Adjusting tool used to back off star wheel
6. Bleeder ----
9. Shoe facing rear in servo brakes
15. Cancer-causing material in brake linings
19. To break up and scatter
21. Automotive Service Excellence (abbr)
22. Levers actuated by a link or wire in automatic adjusters
24. Opposite of *come*
25. Coated with product left after severe heating
29. Part of a brake shoe
31. Brake design used on rear wheels of most American vehicles
32. You and me
34. Prefix meaning *two*
35. Recondition; machine
36. Always
38. Automatically adjusting shoe-to-drum clearance
40. Preposition
41. Compass direction
43. Space between drum and lining
45. Type of pin
47. More than one; a few
49. Southwest (abbr)
51. In non-servo brakes, shoe facing front of vehicle
53. In addition; more
54. Cogs on star wheel
55. Myself
56. Raised area between road and sidewalk
58. Motor
59. Arm pivoted to fit into a slot
61. To operate vehicle with gears disengaged
63. Eccentric discs or lobes
64. Turned or bent to one side
65. Greasy

DOWN

1. Pivoting component that engages pawl in star-wheel teeth
2. Removing metal with a fine abrasive stone
3. Me, --, mine
5. Oklahoma Education Association (abbr)
7. Chief Petty Officer (abbr)
8. Cylinder type used in drum brake operation
10. Defective or nonoperational parts
11. Drum brake valve that prevents leakage at wheel cylinders
12. Drum brake component that may be automatic or manual
13. Action that results when one brake shoe helps apply the other
14. Brake design used on front wheels of most American vehicles
16. ---- wheel; type of manual adjuster
17. Shoe in non-servo brakes that faces rear of vehicle
18. Not hazardous
20. Cause of the majority of brake drum defects
22. Having a center in common
23. Knock out (abbr)
26. Automotive Society (abbr)
27. Char; singe; ignite
28. Frequent cause of brake squeal
30. Removes air from hydraulic system
31. Twisted out of shape
33. Drum brake component that provides mounting surface for lining
37. Right angle (abbr)
39. Forcing material out of its regular shape by high-pressure rubbing
42. Street (abbr)
44. Servo brake shoe facing front of vehicle
46. Having shiny, glass-hard deposits on surface
48. Lined backing plate pad
50. Part of brake shoe
52. Not old
54. Thank goodness it's Friday
57. Part of brake shoe
60. Type of nut on vehicle wheel
62. Eleven (Roman)

Drum Brake Crossword Puzzle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Solution to Drum Brake Crossword Puzzle

■	1 L	■	2 H	■	■	■	■	3 M	I	D	■	4 S	P	5 O	O	N	■	■	6 S	7 C	R	E	8 W
9 S	E	C	O	N	10 D	A	11 R	Y	■	■	12 B	■	■	E	■	■	13 S	■	■	P	■	■	H
■	V	■	N	■	U	■	E	■	14 D	■	R	■	■	15 A	16 S	B	E	S	17 T	O	18 S	■	E
■	E	■	I	■	19 D	I	S	S	I	P	A	T	20 E	■	T	■	R	■	R	■	21 A	S	E
22 C	R	A	N	23 K	S	■	I	■	S	■	K	■	X	■	A	■	V	■	A	■	F	■	L
O	■	■	24 G	O	■	■	D	■	C	■	E	■	25 C	26 A	R	27 B	O	N	I	Z	E	28 D	■
29 N	I	30 B	■	■	31 D	R	U	M	B	R	A	K	E	S	■	U	■	■	L	■	■	32 U	33 S
C	■	L	■	34 B	I	■	A	■	R	■	D	■	S	■	■	R	■	35 F	I	N	I	S	H
36 E	V	E	37 R	■	38 S	E	L	F	A	D	J	U	S	T	I	N	39 G	■	N	■	■	40 T	O
N	■	41 E	A	42 S	T	■	■	■	K	■	U	■	I	■	■	■	A	■	43 G	A	44 P	■	E
T	■	D	■	45 T	O	G	46 G	L	E	■	47 S	E	V	E	48 R	A	L	■	■	■	R	■	■
R	■	49 S	50 W	■	R	■	L	■	■	■	T	■	E	■	I	■	51 L	E	A	D	I	52 N	G
I	■	■	53 E	X	T	R	A	■	54 T	E	E	T	H	■	D	■	I	■	■	■	55 M	E	■
56 C	U	57 R	B	■	E	■	Z	■	G	■	R	■	58 E	N	G	I	N	E	■	59 P	A	W	60 L
■	■	I	■	61 I	D	L	E	■	I	■	■	■	A	■	E	■	G	■	62 X	■	R	■	U
63 C	A	M	S	■	■	■	64 D	E	F	L	E	C	T	E	D	■	■	65 O	I	L	Y	■	G

SUPPLEMENT 2

Characteristics of Good Brake Linings

Are resistant to heat fade — Are able to maintain effectiveness at high temperatures

Recover quickly — Are able to return rapidly to their pre-fade friction level under cooling conditions

Have good speed sensitivity — Are able to maintain effectiveness against drum surface at varying speeds

Are resistant to water fade — Are able to give maximum performance and long wear without damaging drum surface

Have operating stability — Have suitable wear life in the anticipated range of brake heat

Operate quietly — Provide nearly noiseless, odor-free operation

Are of quality manufacture — Are made of quality ingredients that are properly cured

EXAMPLES: *Competitive* — Flexible low-priced linings bonded to shoe; contain large amounts of fillers and low-quality asbestos; are cured in rolls rather than individually, and curing time is brief

Standard — Semirigid, medium-priced linings to which wire backings are sometimes added for support; are riveted or bonded to shoe, and contain ingredients of average quality

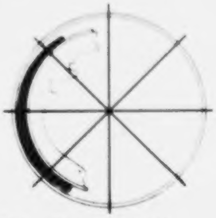
Premium — Highest-priced linings, fully cured in rigid segments and containing the finest ingredients

NOTE: Premium linings have a longer life than competitive or standard linings, withstand higher temperatures, and provide a higher resistance to fade.

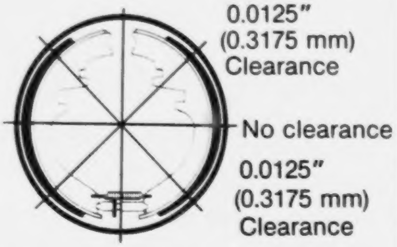
Are shaped appropriately for application — Are correctly shaped for servo or non-servo brake action and for proper wearing in to match the drum

Brake Shoe Grinds

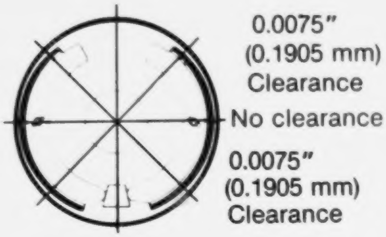
Modern brake shoes are usually supplied in what is known as a *cam*, *offset*, *contour*, or *eccentric* shape that is ground at the factory. That is, the fullest thickness of the lining is at the middle of the shoe, but the shoe is ground down slightly at the heel and toe. The diameter of the circle the shoes make is slightly smaller than that of the drum. This compensates for the minor tolerance variations of drums, brake mountings, etc., and promotes proper wearing in of the linings to match the drums. See illustrations below.



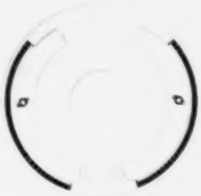
OEM offset grind
furnished on new vehicles



Contour (eccentric) grind, servo



Contour (eccentric)
grind, non-servo



Concentric grind

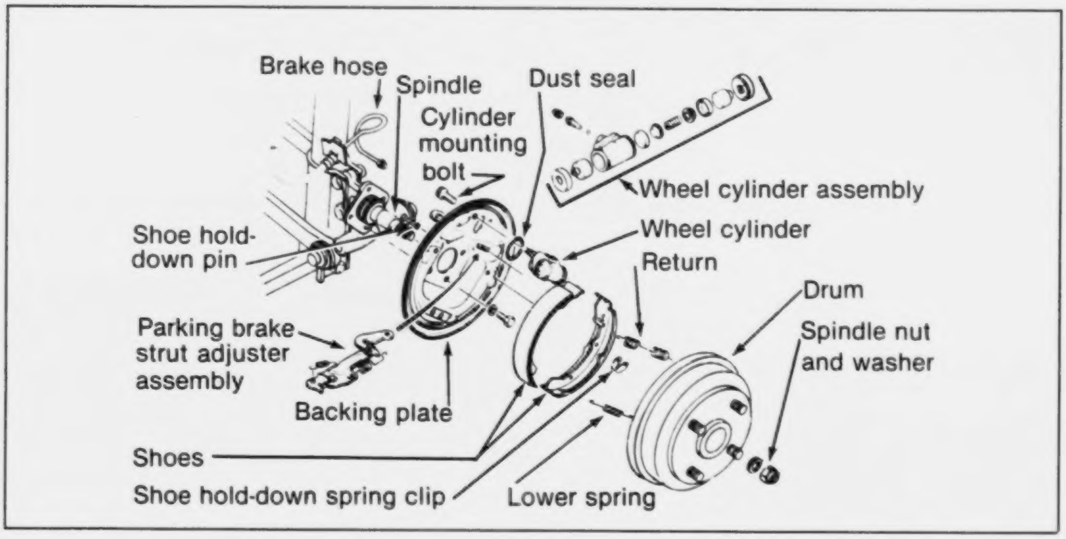
Since most automotive shoes are manufactured this way, the once common practice of arcing the shoes in the shop to match the drums has become unnecessary; thus, the health danger of working with asbestos dust during this procedure is avoided.

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

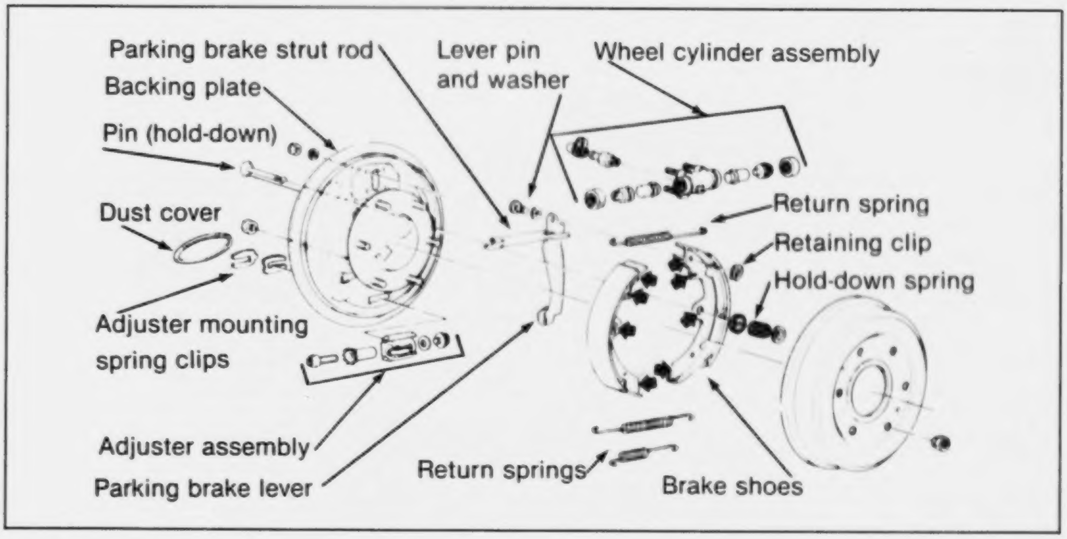
SUPPLEMENT 3

Types of Import Drum Brakes

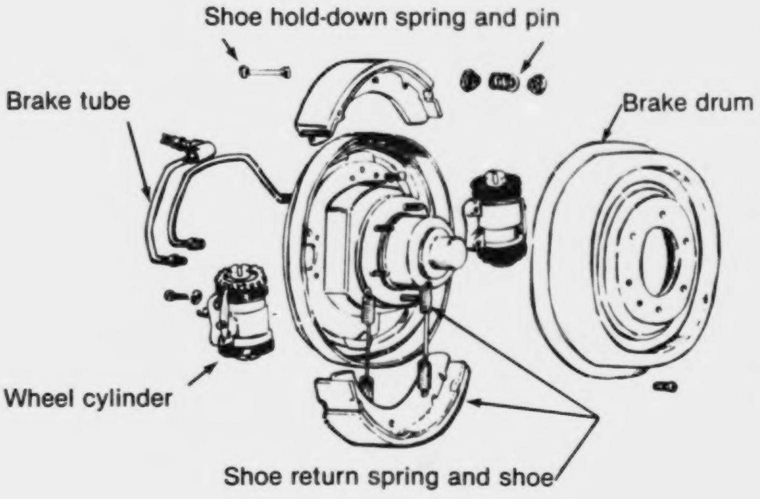
- Japanese drum with ratchet adjuster


Brake hose
Spindle
Dust seal
Cylinder mounting bolt
Wheel cylinder assembly
Shoe hold-down pin
Wheel cylinder
Return
Drum
Spindle nut and washer
Parking brake strut adjuster assembly
Backing plate
Shoes
Shoe hold-down spring clip
Lower spring

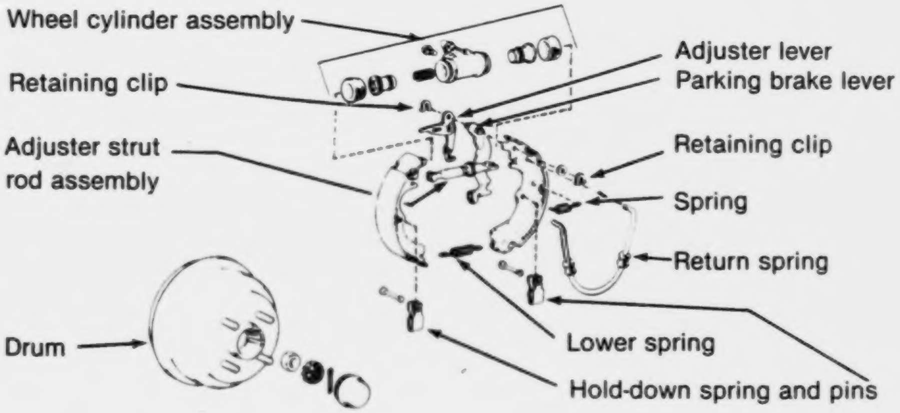
- Nissan drum with dual star-wheel adjuster


Parking brake strut rod
Lever pin and washer
Wheel cylinder assembly
Backing plate
Pin (hold-down)
Return spring
Dust cover
Retaining clip
Hold-down spring
Adjuster mounting spring clips
Adjuster assembly
Parking brake lever
Return springs
Brake shoes

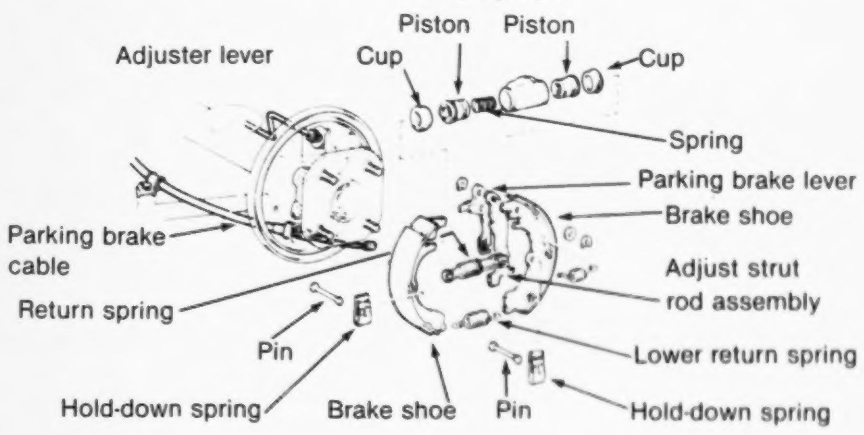
- Dual wheel cylinder drum


Shoe hold-down spring and pin
Brake tube
Brake drum
Wheel cylinder
Shoe return spring and shoe

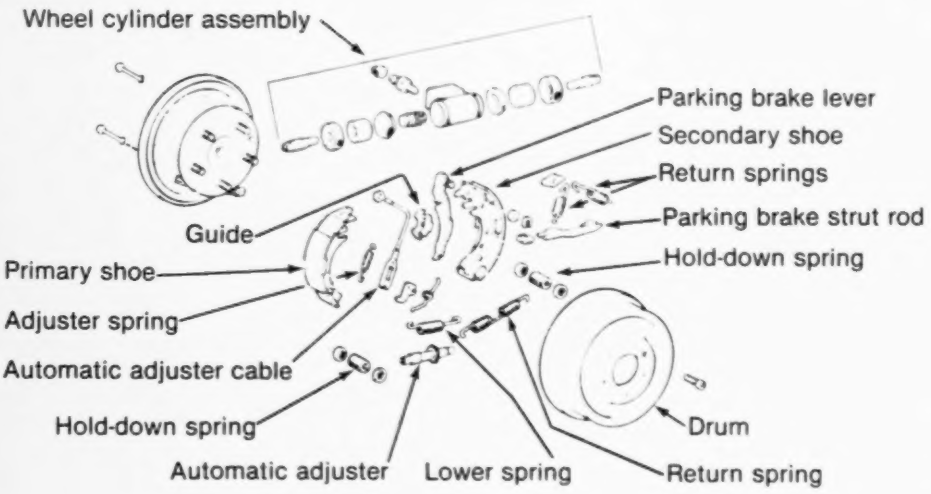
- Drum with U-type return spring


Wheel cylinder assembly
Retaining clip
Adjuster strut
rod assembly
Drum
Adjuster lever
Parking brake lever
Retaining clip
Spring
Return spring
Lower spring
Hold-down spring and pins

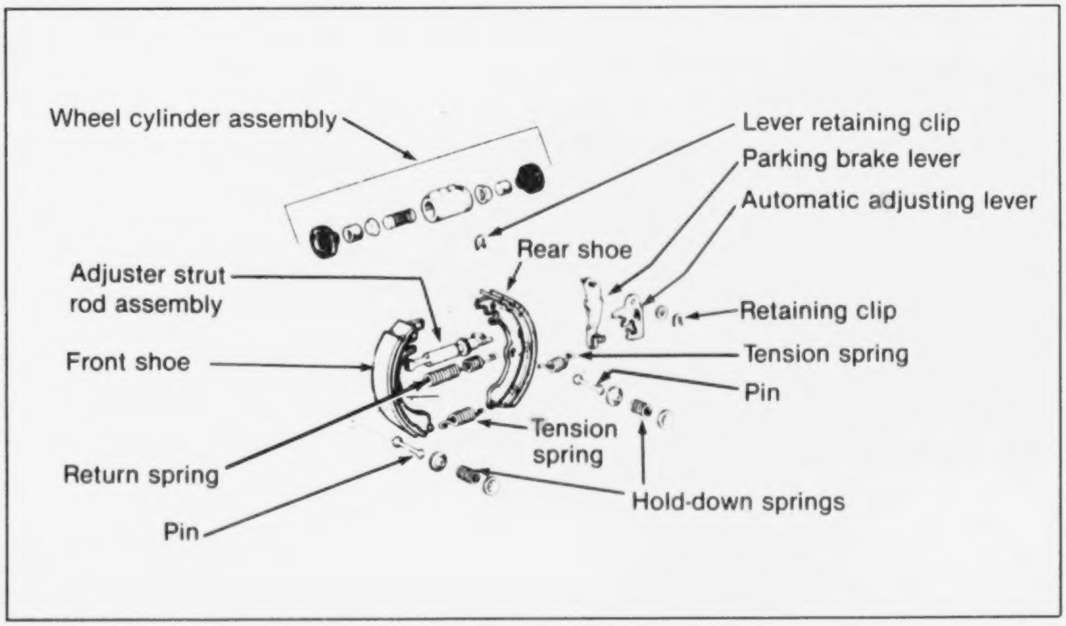
- Toyota with star-wheel adjuster


Wheel cylinder
Piston
Piston
Adjuster lever
Cup
Cup
Spring
Parking brake lever
Brake shoe
Parking brake cable
Adjust strut rod assembly
Return spring
Lower return spring
Pin
Hold-down spring
Brake shoe
Pin
Hold-down spring

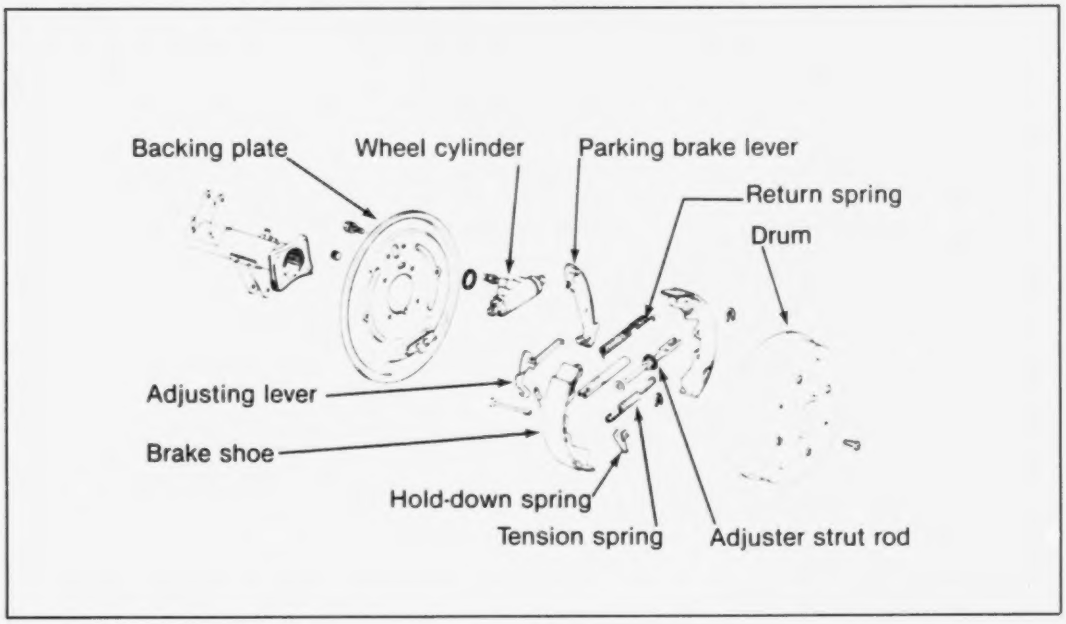
- Japanese, Chrysler drum with cable automatic adjuster


Wheel cylinder assembly
Parking brake lever
Secondary shoe
Return springs
Guide
Parking brake strut rod
Hold-down spring
Primary shoe
Adjuster spring
Automatic adjuster cable
Hold-down spring
Drum
Automatic adjuster
Lower spring
Return spring

- Toyota drum with lever automatic adjuster

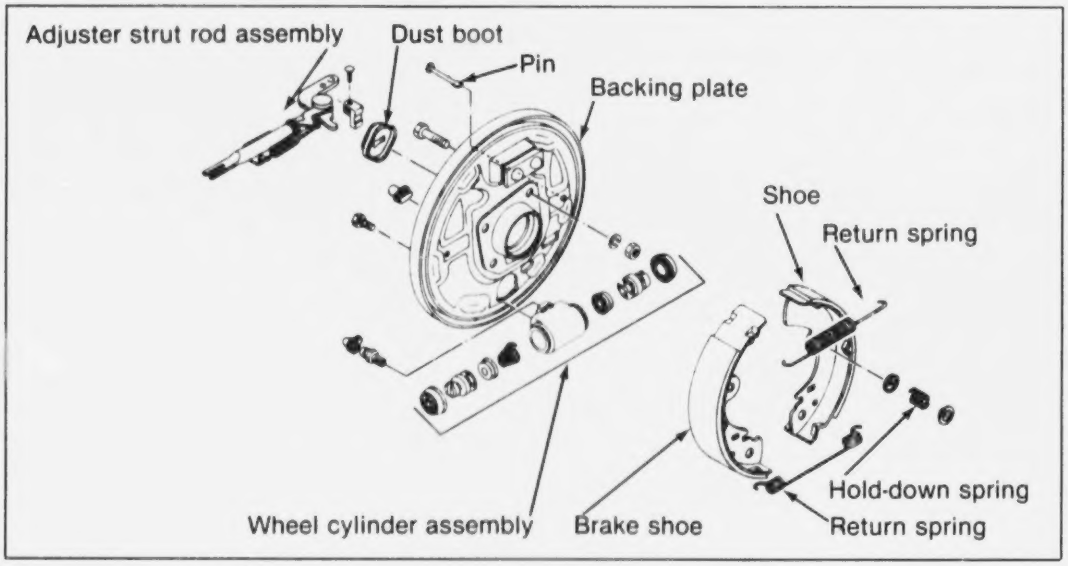

Wheel cylinder assembly
Lever retaining clip
Parking brake lever
Automatic adjusting lever
Rear shoe
Adjuster strut rod assembly
Retaining clip
Front shoe
Tension spring
Pin
Tension spring
Return spring
Hold-down springs
Pin

- Mazda, Volkswagen with star-wheel adjuster

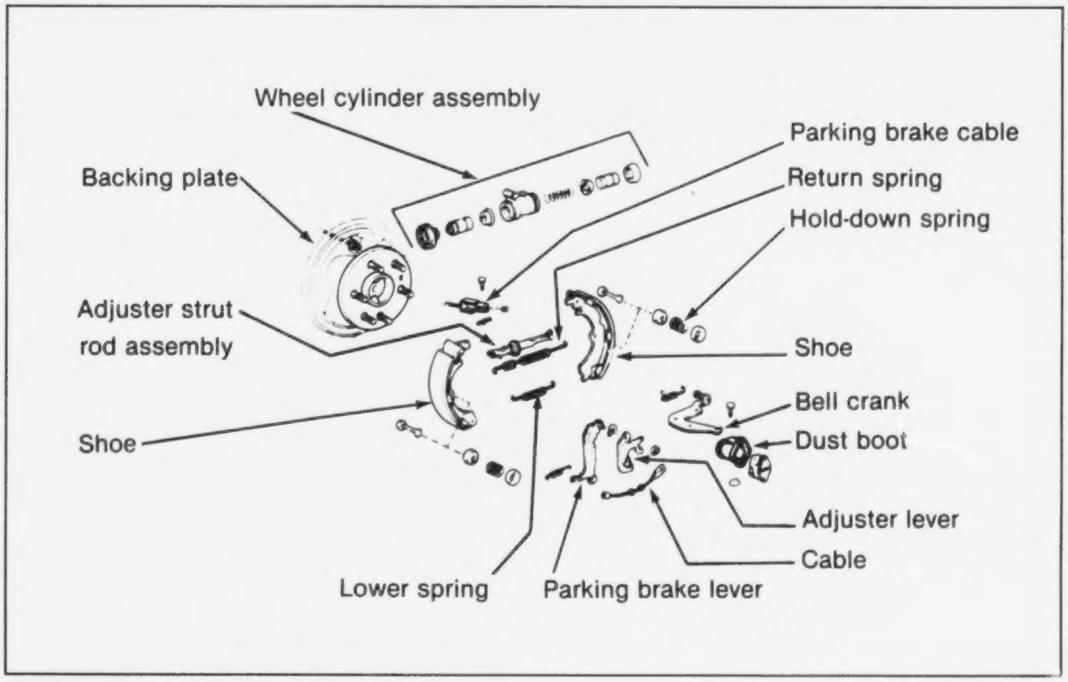

Backing plate
Wheel cylinder
Parking brake lever
Return spring
Drum
Adjusting lever
Brake shoe
Hold-down spring
Tension spring
Adjuster strut rod

311

- Nissan with strut rod adjuster

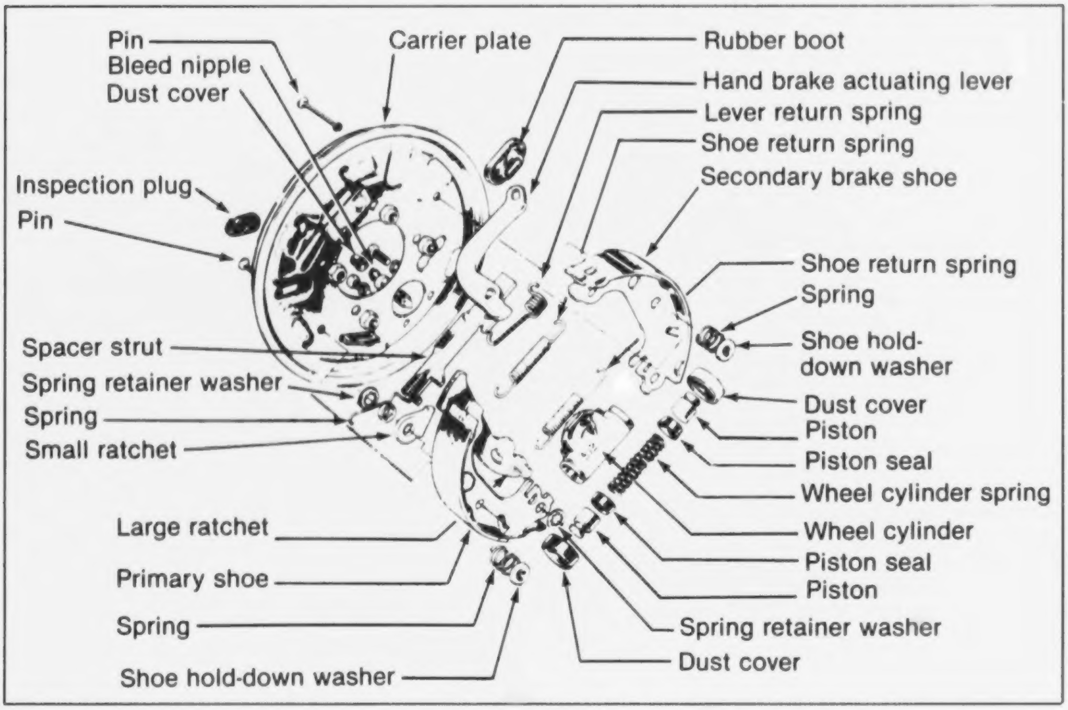

Adjuster strut rod assembly
Dust boot
Pin
Backing plate
Shoe
Return spring
Hold-down spring
Return spring
Brake shoe
Wheel cylinder assembly

- Toyota rear drum with cable automatic adjuster

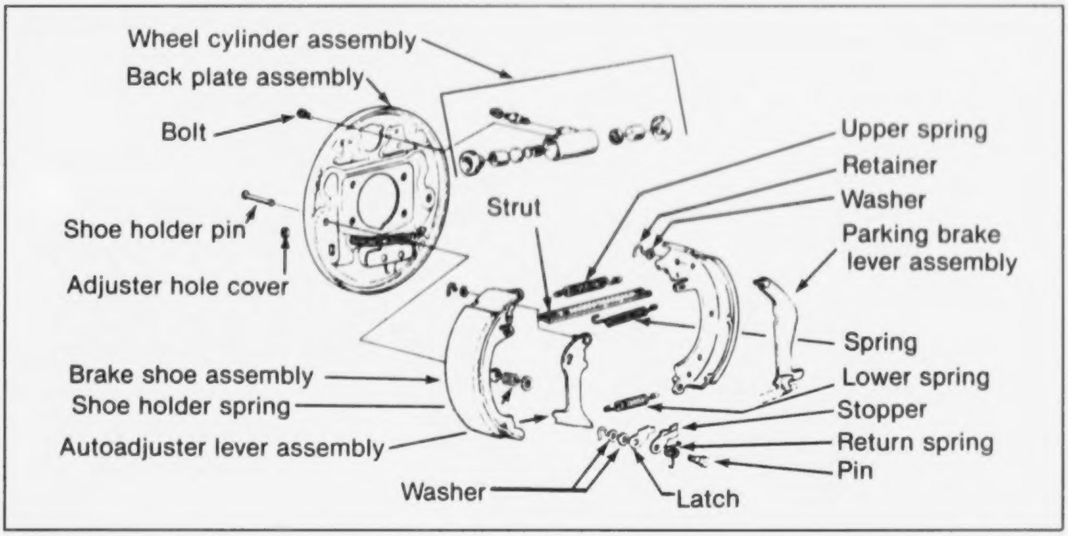

Wheel cylinder assembly
Parking brake cable
Return spring
Hold-down spring
Backing plate
Adjuster strut rod assembly
Shoe
Shoe
Bell crank
Dust boot
Adjuster lever
Cable
Lower spring
Parking brake lever

312

- Fiesta rear drum with ratchet adjuster

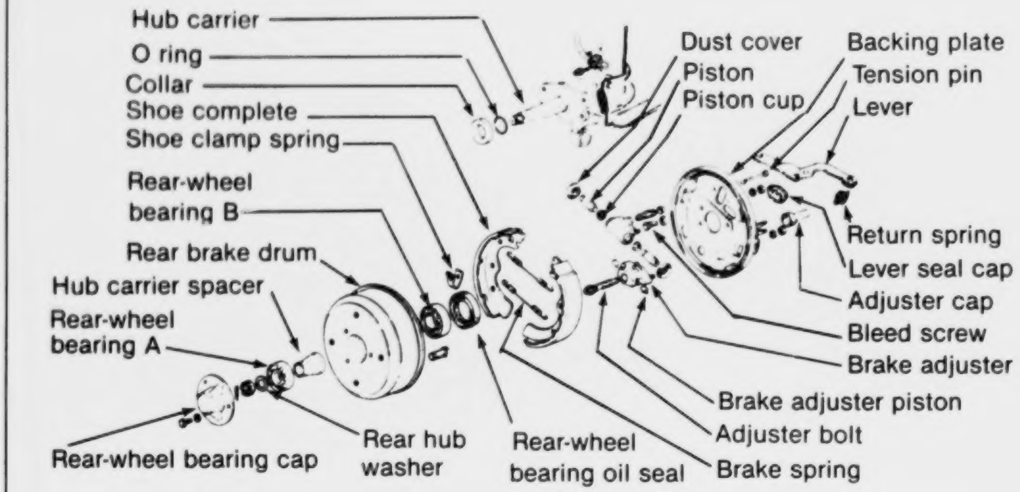

Pin
Bleed nipple
Dust cover
Carrier plate
Rubber boot
Hand brake actuating lever
Lever return spring
Shoe return spring
Secondary brake shoe
Inspection plug
Pin
Shoe return spring
Spring
Shoe hold-down washer
Spacer strut
Spring retainer washer
Spring
Small ratchet
Dust cover
Piston
Piston seal
Wheel cylinder spring
Wheel cylinder
Large ratchet
Piston seal
Piston
Primary shoe
Spring
Spring retainer washer
Dust cover
Shoe hold-down washer

- Rear drum with ratchet adjuster

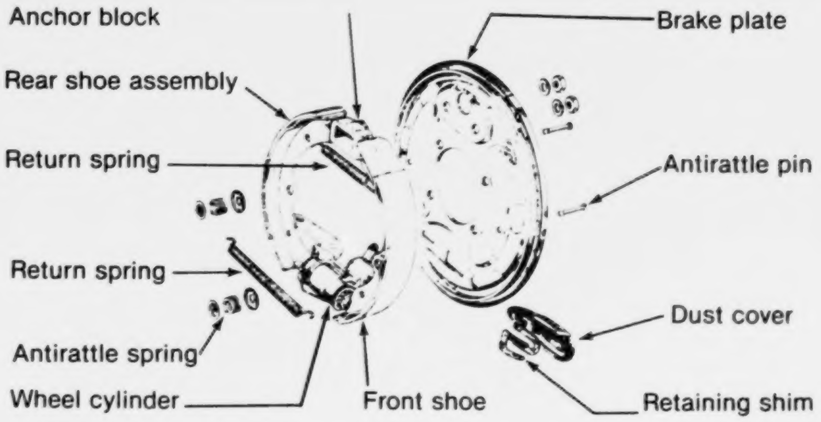

Wheel cylinder assembly
Back plate assembly
Bolt
Upper spring
Retainer
Washer
Strut
Shoe holder pin
Parking brake lever assembly
Adjuster hole cover
Spring
Lower spring
Brake shoe assembly
Shoe holder spring
Stopper
Autoadjuster lever assembly
Return spring
Pin
Washer
Latch

31

- Rear drum with wedge (tapered) adjuster


Hub carrier
O ring
Collar
Shoe complete
Shoe clamp spring
Rear-wheel bearing B
Rear brake drum
Hub carrier spacer
Rear-wheel bearing A
Rear-wheel bearing cap
Rear hub washer
Rear-wheel bearing oil seal
Dust cover
Piston
Piston cup
Backing plate
Tension pin
Lever
Return spring
Lever seal cap
Adjuster cap
Bleed screw
Brake adjuster
Brake adjuster piston
Adjuster bolt
Brake spring

- Nissan rear drum (adjustment maintained by parking brake operation)


Anchor block
Rear shoe assembly
Return spring
Return spring
Antirattle spring
Wheel cylinder
Front shoe
Brake plate
Antirattle pin
Dust cover
Retaining shim

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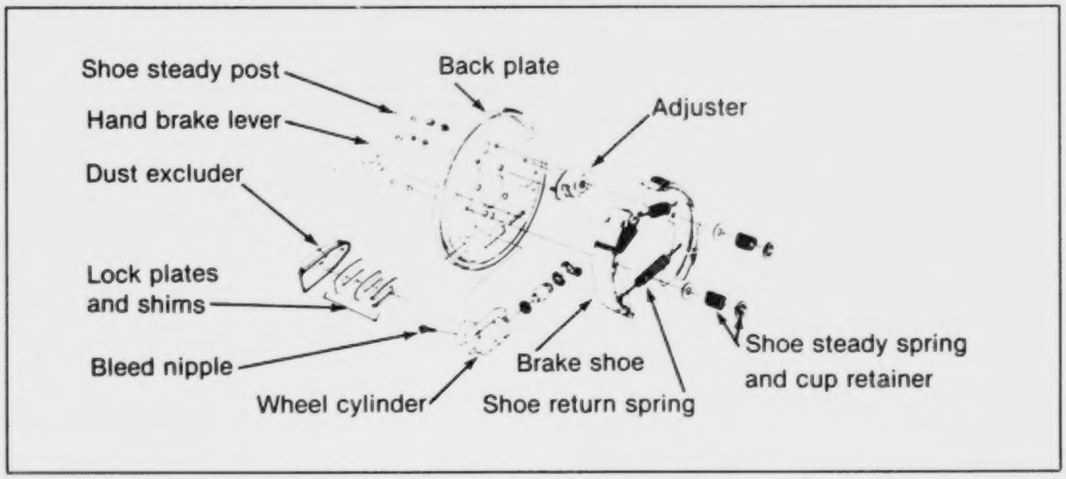
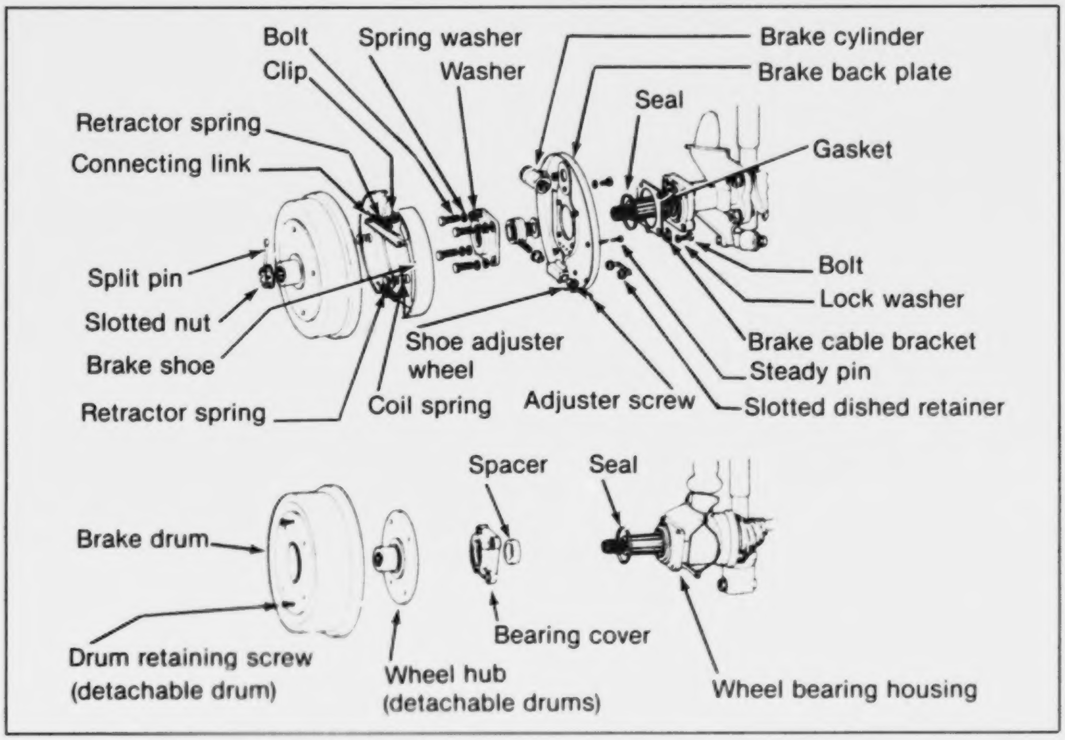
- Rear drum with single-piston wheel cylinder (moving)

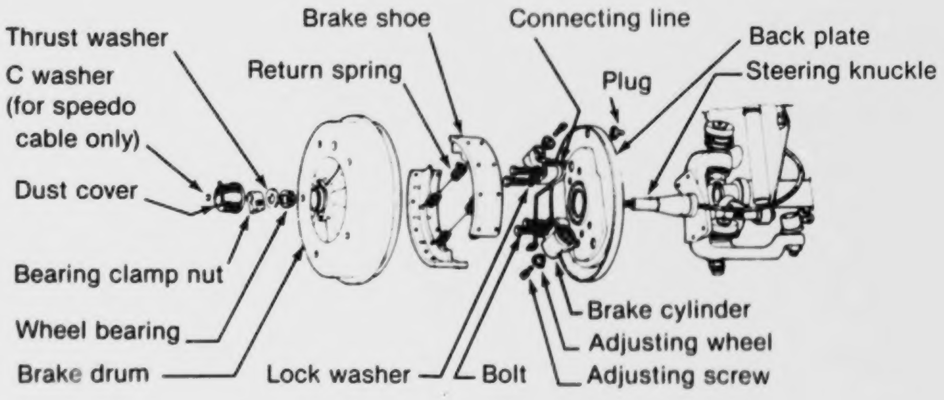

Shoe steady post
Back plate
Hand brake lever
Adjuster
Dust excluder
Lock plates
and shims
Bleed nipple
Wheel cylinder
Brake shoe
Shoe return spring
Shoe steady spring
and cup retainer

- Volkswagen with dual star-wheel adjuster


Bolt
Clip
Spring washer
Washer
Brake cylinder
Brake back plate
Seal
Retractor spring
Connecting link
Gasket
Split pin
Slotted nut
Brake shoe
Retractor spring
Shoe adjuster
wheel
Coil spring
Adjuster screw
Bolt
Lock washer
Brake cable bracket
Steady pin
Slotted dished retainer
Spacer
Seal
Brake drum
Drum retaining screw
(detachable drum)
Wheel hub
(detachable drums)
Bearing cover
Wheel bearing housing

315

- Dual cylinder drum


Thrust washer
C washer (for speedo cable only)
Dust cover
Bearing clamp nut
Wheel bearing
Brake drum
Brake shoe
Return spring
Lock washer
Bolt
Connecting line
Plug
Back plate
Steering knuckle
Brake cylinder
Adjusting wheel
Adjusting screw

This supplement adapted with permission of Allied Aftermarket.

INSTRUCTOR'S SUPPLEMENTS

SERVICE DRUM BRAKES

SUPPLEMENT 4

Brake System Inspection Report Form

Customer name ____________________

Address ____________ Telephone number: Work ____________ Home ____________

Vehicle make ____________ Year ____________ Mileage ____________

License number ____________________

Approximate time required for service ____________________

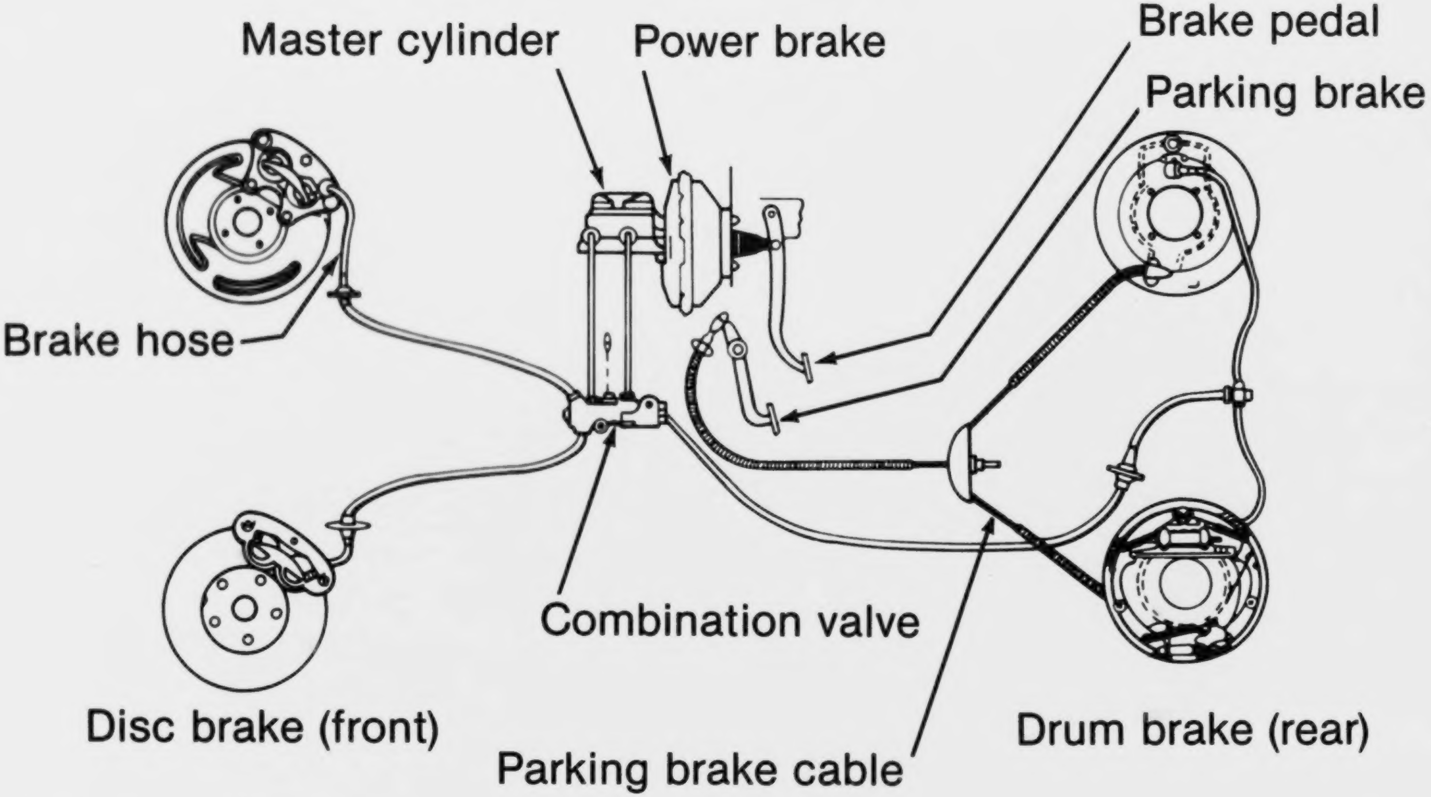
Inspected by ____________________ Date ____________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate**	
		Parts	**Labor**
Disc pads	☐Semi-metallic ☐Conventional		
Disc caliper	☐Recondition ☐Replace		
Disc hardware	☐Replace		
Disc rotor	☐Recondition ☐Replace		
Grease seals	☐Replace		
Front wheel bearings	☐Repack ☐Replace		
Wheel cylinders	☐Recondition ☐Replace		
Rear brake hardware	☐Replace		
Brake shoes	☐Replace		
Brake drums	☐Recondition ☐Replace		
Parking brakes	☐Adjust ☐Lubricate ☐Replace		
Power brake booster	☐Service ☐Replace		
Master cylinder	☐Recondition ☐Replace		
Brake fluid	☐Drain old, and add new fluid		
Lines, hoses, combination valve	☐Replace		
Stop light, warning light	☐Replace bulb ☐Replace switch ☐Adjust ☐Replace		
Other ____________			
	Total		

317

Components of a Tandem or Dual Brake System


Master cylinder
Power brake
Brake pedal
Parking brake
Brake hose
Combination valve
Disc brake (front)
Parking brake cable
Drum brake (rear)

Used with permission of Allied Aftermarket.

Parts of a Typical Drum Brake Shoe

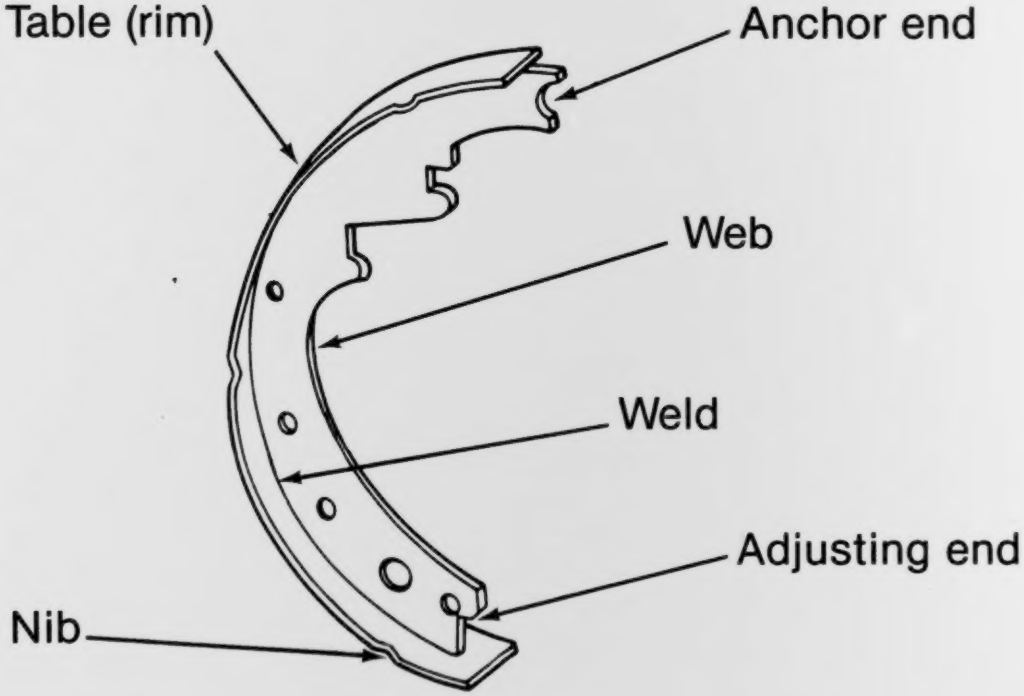
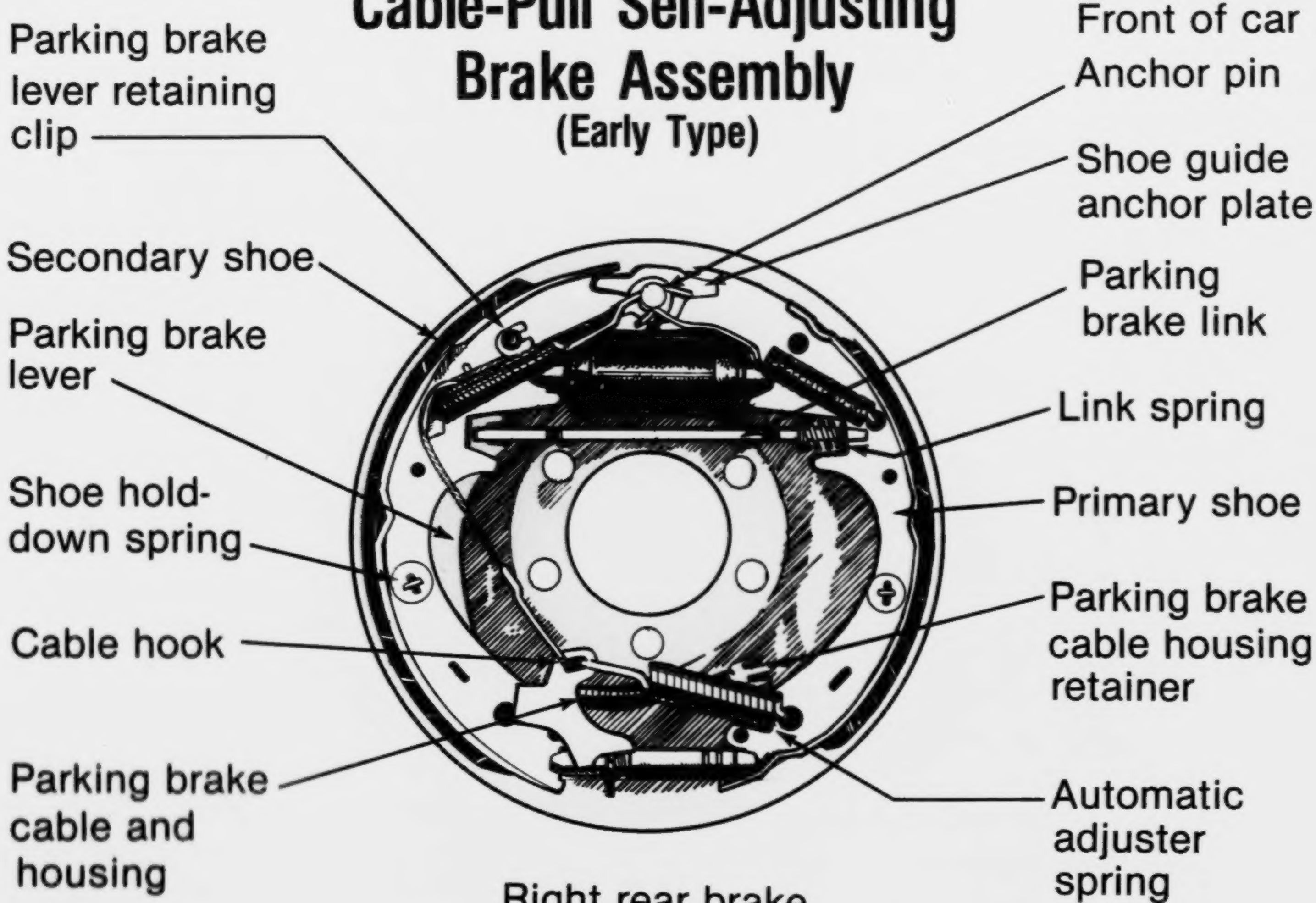


Table (rim)
Anchor end
Web
Weld
Adjusting end
Nib

Used with permission of Allied Aftermarket.

Cable-Pull Self-Adjusting Brake Assembly

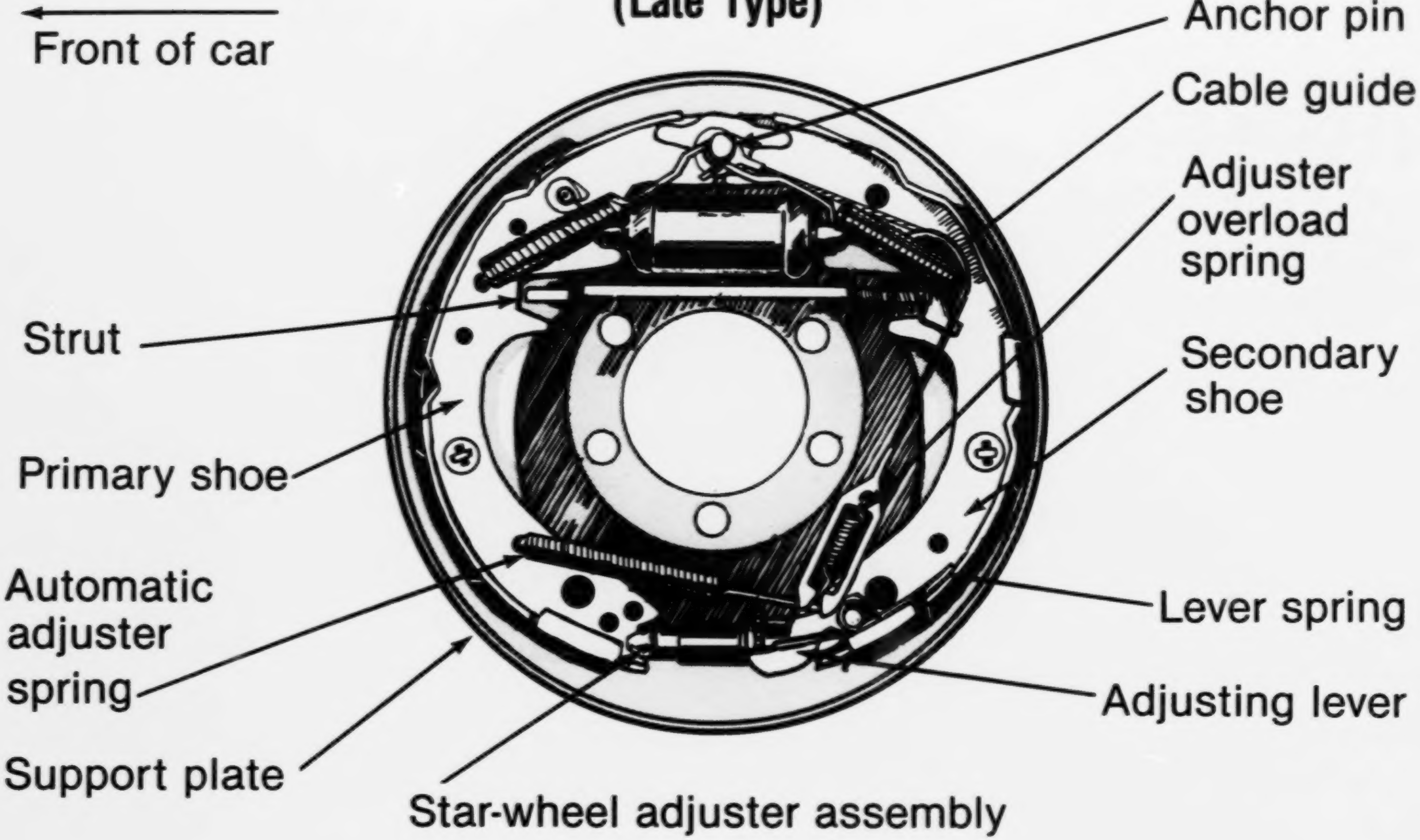
(Early Type)


Front of car
Anchor pin
Shoe guide anchor plate
Parking brake link
Link spring
Primary shoe
Parking brake cable housing retainer
Automatic adjuster spring
Parking brake lever retaining clip
Secondary shoe
Parking brake lever
Shoe hold-down spring
Cable hook
Parking brake cable and housing

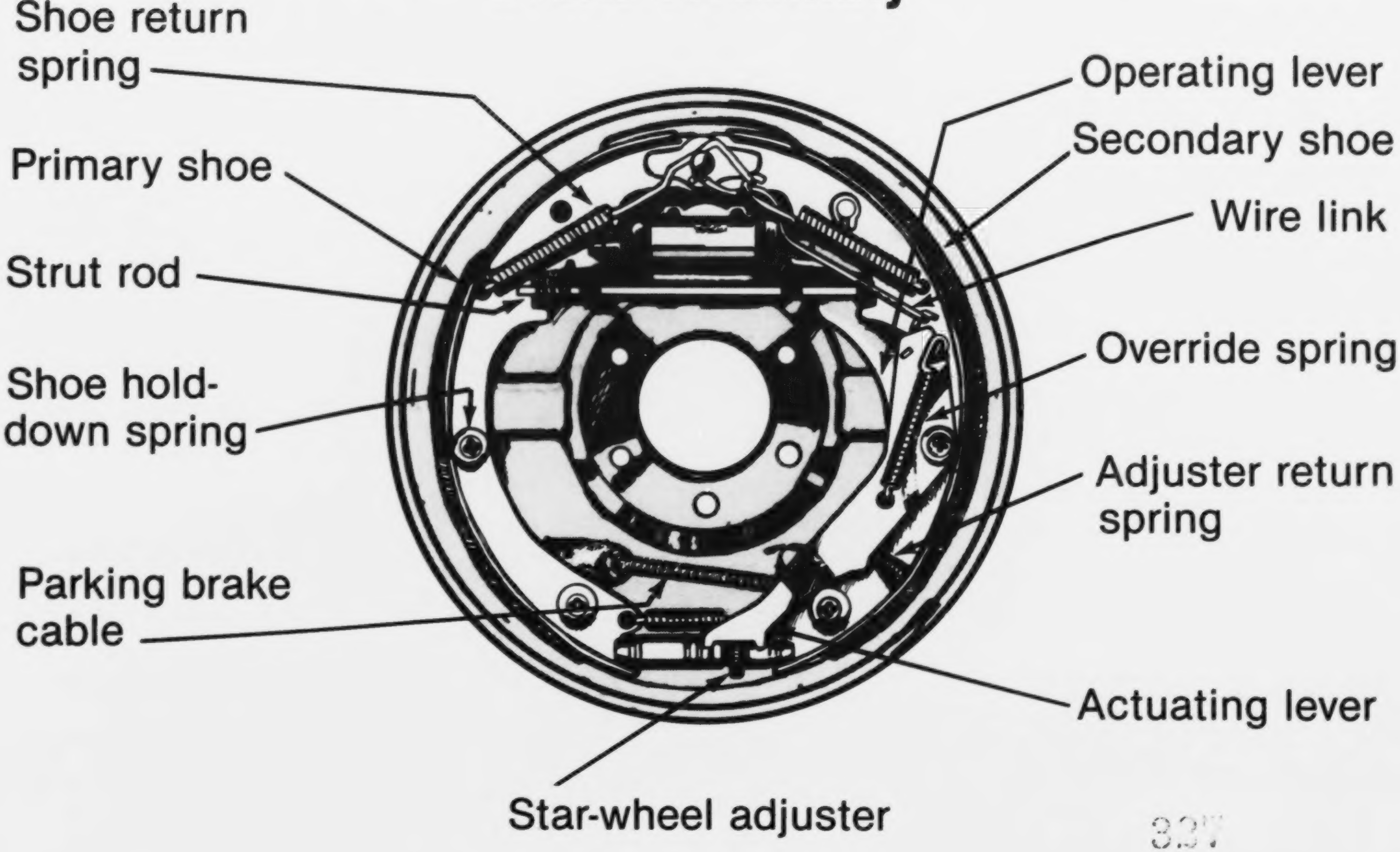
Right rear brake

Cable-Pull Self-Adjusting Brake Assembly

(Late Type)


Front of car
Anchor pin
Cable guide
Adjuster overload spring
Secondary shoe
Strut
Primary shoe
Automatic adjuster spring
Lever spring
Adjusting lever
Support plate
Star-wheel adjuster assembly

Lever-Type Self-Adjusting Brake Assembly


Shoe return spring
Primary shoe
Strut rod
Shoe hold-down spring
Parking brake cable
Star-wheel adjuster
Operating lever
Secondary shoe
Wire link
Override spring
Adjuster return spring
Actuating lever

PRETEST ANSWERS

SERVICE DRUM BRAKES

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from the pretest results, use the following table, which shows the correlation between the objectives and written pretest questions. Then counsel students individually on pretest results and study requirements.

TABLE

Correlation between objectives and written pretest questions

Objective	Question
1	1, 2
2	3, 4
3	5
4	6, 7
5	8
6	9
7	10
8	19
9	20, 24
10	11
11	22
12	12
13	14
14	21, 25
15	15, 16
16	13
17	23
18	17, 18

ANSWER KEY

1. b
2. a
3. d
4. a
5. d
6. c
7. c
8. c
9. b
10. c
11. b
12. c
13. a
14. a
15. d
16. b
17. c
18. d
19. a
20. a
21. b
22. b
23. b
24. c
25. c

PRETEST

SERVICE DRUM BRAKES

Name ______________________________ Score ________________

DIRECTIONS

Read the following questions and problems. Then circle the letter before the item that best answers the question or solves the problem.

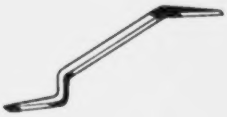
1. Which of the following is the best definition of *servo action*?

   a. Process of compensating for shoe wear by automatically adjusting shoe-to-drum clearance
   b. Process that results when both shoes are free to swing into drum, and primary shoe helps apply secondary shoe
   c. Use of friction to force one brake shoe tighter against drum
   d. Use of residual valve to apply pressure to drum brake assembly to prevent leakage at wheel cylinders

2. Which of the following is the best definition of *primary shoe*?

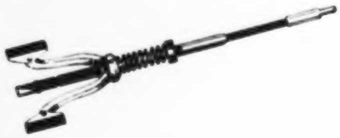
   a. In servo brakes, that shoe toward front of forward-moving vehicle
   b. In non-servo brakes, that shoe toward front of froward-moving vehicle
   c. In non-servo brakes, that shoe toward rear of forward-moving vehicle
   d. In servo brakes, that shoe toward rear of forward-moving vehicle

3. For which of the following procedures would the tool illustrated below be used?



   a. Bleeding wheel cylinder
   b. Prying springs off anchor pin
   c. Removing and installing hold-down springs
   d. Backing off star wheel for drum removal

4. For which of the following procedures would the tool illustrated below be used?

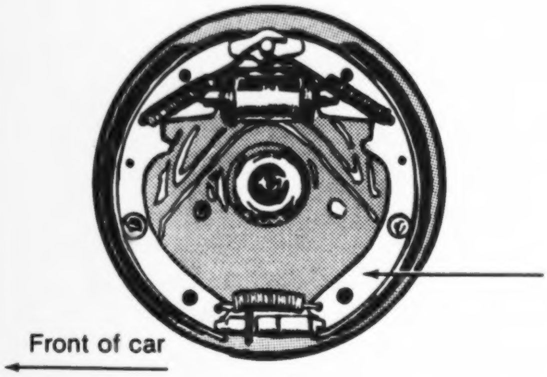


   a. Reconditioning wheel cylinder bore
   b. Measuring drum diameter
   c. Measuring and adjusting lining-to-drum clearance
   d. Grinding out hardened areas on drums

5. In drum brake operation, the brake shoes are pushed against a rotating drum by

   a. Master cylinder pistons
   b. Accumulator pistons
   c. A power booster
   d. Wheel cylinder pistons

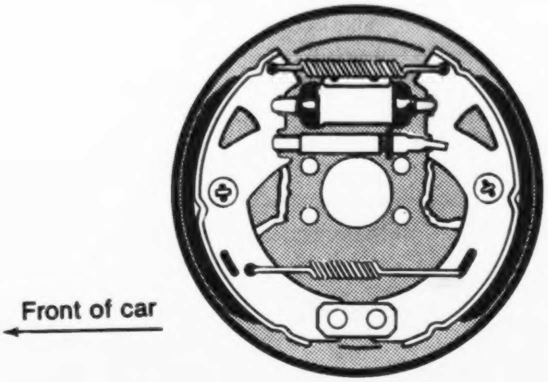
6. To what component of the duo-servo brake assembly illustrated below is the arrow pointing?



Adapted with permission of Raybestos/Brake Systems Inc.

   a. Primary shoe
   b. Anchor pin
   c. Secondary shoe
   d. Star-wheel adjuster

7. To what component of the non-servo brake assembly illustrated below is the arrow pointing?



a. Anchor block
b. Adjusting cam
c. Brake shoe retracting spring
d. Brake shoe retaining spring

8. Which of the following is a function of the drum brake assembly star-wheel adjuster?

a. Prevents shoe from turning with brake drum
b. Pulls shoes away from drum when brakes are released
c. Pushes shoes farther apart as lining wears
d. Pushes brake shoes out into contact with drum

9. If a component is wallowed, it has

a. Been turned or bent to one side
b. Enlarged or misshappen holes
c. Shiny, glass-hard deposits on the surface
d. Lost its braking friction due to excessive heat

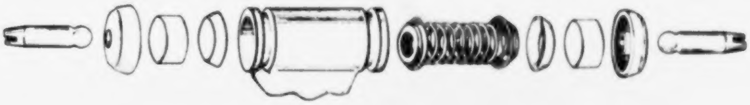
10. Which of the following defects would you look for when visually inspecting a drum brake backing plate?

a. Overheating
b. Hot spots
c. Pads for ridges or steps
d. Uneven wear

11. Which of the following is **not** a common type of brake shoe mounting?

    a. Single-anchor self-centering
    b. Single-anchor non-centering
    c. Double-anchor double-cylinder
    d. All of the above

12. Which of the typical wheel cylinder components illustrated below is in the wrong position?



Adapted with permission of McGraw-Hill Book Company, Gregg Division, from *Automotive Mechanics*, 8th ed., by William H. Crouse, 1980.

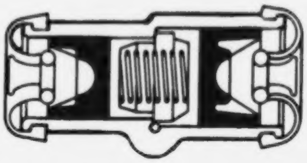
    a. Boot
    b. Actuating pin
    c. Piston
    d. Spring

13. When adjusting brake shoes,

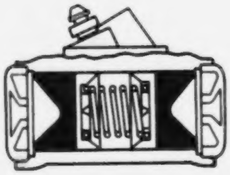
    a. Check the self-adjusting mechanism for broken or improperly installed parts
    b. There is no need to ever adjust the self-adjusting mechanism
    c. Manual adjustment of the star wheel is unnecessary
    d. The lining-to-drum clearance is measured with a drum brake micrometer

14. Of the wheel cylinders illustrated below and at the top of the next page, which is a double-piston step-bore design?

A

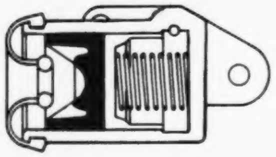


B

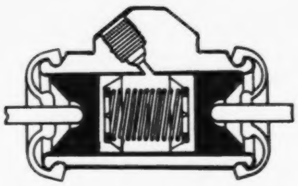


333

C



D



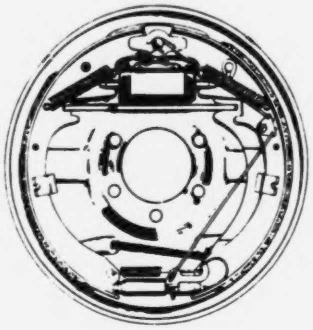
Illustrations A through D used with permission of Allied Aftermarket.

a. A
b. B
c. C
d. D

15. Which of the following brake shoe adjusters is **not** automatic?

a. Rod and strut assembly
b. Eccentric cam
c. Link or crank
d. Star wheel

16. What type of automatic brake shoe adjuster is shown below?



Used with permission of Allied Aftermarket.

a. Cable
b. Link (crank)
c. Lever
d. Ratchet

17. Which of the following would be the *most likely* cause of a clicking noise during vehicle operation?

   a. Loose backing plate
   b. Improper lining shape
   c. Threaded drum surface
   d. Drum silencer spring missing or weak

18. When servicing a customer's vehicle, you find that the brake backing plate is bent. Which of the following would be the proper corrective measure?

   a. Machine backing plate to recommended dimension
   b. Heat backing plate and use rubber mallet to straighten
   c. Adjust anchor pin (if provided)
   d. Replace backing plate

19. Drum retaining clips

   a. Should be discarded when removing drum
   b. Should be replaced in matched pairs
   c. Should be installed counterclockwise when reinstalling drum
   d. Must be installed in sequence recommended by manufacturer

20. When refinishing brake drums, which of the following statements is true?

   a. Brake drums must be replaced if they are oversized
   b. A drum brake lathe can be used to correct all brake drum defects except cracking
   c. Brake drums do not need to be replaced if they are not oversized before refinishing but are oversized after refinishing
   d. Always clean metal particles from newly refinished drums with air pressure

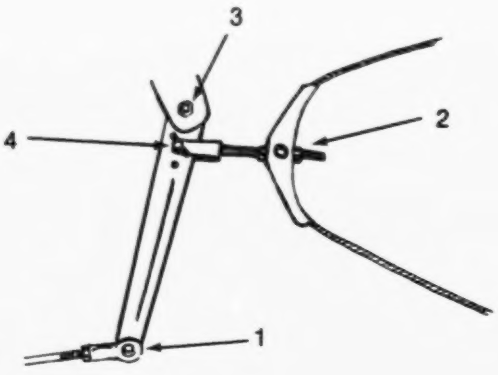
21. When reconditioning a cylinder bore, do **not** increase the bore by more than

   a. 0.001 inch
   b. 0.002 inch
   c. 0.003 inch
   d. 0.004 inch

22. When servicing brake shoes and linings, which of the following statements is true?

   a. Replace bonded lining if it is worn to less than 1/8 inch
   b. Replace riveted lining if it is worn to less than 1/32 inch over heads of rivets
   c. Replace riveted lining if it is worn to less than 1/8 inch
   d. None of the above

23. At which of the numbered locations below is the parking brake adjustment usually made?



   a. 1
   b. 2
   c. 3
   d. 4

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., © 1983, p. 23, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

24. Drums should be inspected and refinished

   a. One at a time, beginning with the wheel nearest the master cylinder
   b. One at a time, beginning with the wheel farthest from the master cylinder
   c. In pairs, inspecting and refinishing the drums on the same axle
   d. In pairs, inspecting and refinishing the drums on the same side of the vehicle

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25. When preparing to remove a wheel cylinder, the brake line should be

a. Left connected until the hydraulic system has been drained
b. Left connected until the cylinder has been inspected to make sure that the system has adequate fluid flow
c. Disconnected at the wheel cylinder and then plugged to prevent fluid loss
d. Disconnected at the frame connection and plugged and then disconnected from the wheel cylinder

INFORMATION SHEET

SERVICE DRUM BRAKES

OBJECTIVE 1

Recognize definitions of terms associated with drum brakes

Drum brake — Brake design in which curved brake shoes press against inner circumference of a rotating metal drum to produce braking action

Dissipate — To break up and scatter; to disperse or make disappear

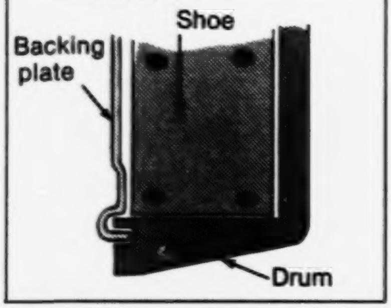
Eccentric — Disc or lobe (cam) used to convert rotary action to reciprocating action; off-center

Flange — Projecting lip, rim, or edge

Labyrinth seal — Seal formed by backing plate flange and drum rim that prevents water splashed from road to enter brake mechanism (Figure 1)

EXAMPLE:

FIGURE 1



Primary shoe — In servo brakes, that shoe toward front of forward-moving vehicle

NOTE: In non-servo brakes, this shoe is called the *forward* or *leading* shoe.

Secondary shoe — In servo brakes, that shoe toward rear of forward-moving vehicle

NOTE: In non-servo brakes, this shoe is called the *reverse* or *trailing* brake shoe.

Primary and Secondary Shoes

The chief difference between primary and secondary shoes is the location; however, depending on the manufacturer, length and width of the shoes may also be different. The secondary shoe, the rear shoe of the set, normally has a full-length lining, centered on the shoe. The primary shoe, the front shoe of the set, may be shorter and/or narrower than the secondary shoe, but not always. Many imported pickups use the same size shoe and lining, but the composition of the lining materials differs. Additionally, brake shoes located on the front wheels are usually wider than those on the rear wheel set. Finally, the diameter of the front set of brake shoes may be larger than that of the rear set of shoes—for example, 10-inch front brakes and 9-inch rear.

Pawl — Arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary

Recondition — To machine or return a part to its original surface condition

Honing — Removing metal with a fine abrasive stone

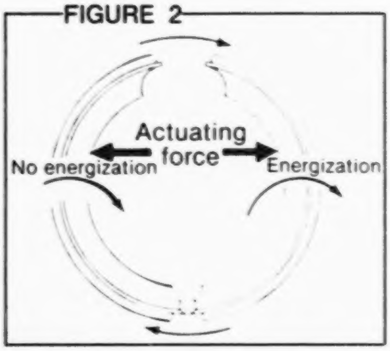
Residual valve — Device that maintains pressure in the system after brake pedal is released to prevent leakage at wheel cylinders

Self-adjusting — Process of compensating for shoe wear by automatically adjusting shoe-to-drum clearance

Self-energizing — Use of friction to force one brake shoe tighter against drum (Figure 2)

EXAMPLE:

FIGURE 2

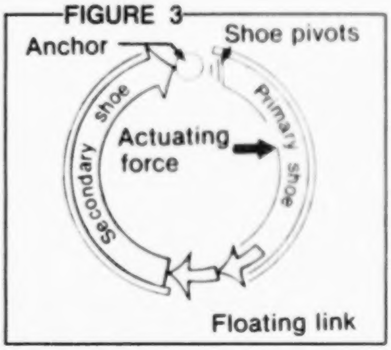

Actuating force
No energization
Energization

Used with permission of EIS Corporation.

Servo action — Process that results when both shoes are free to swing into drum, and primary shoe helps apply secondary shoe (Figure 3)

EXAMPLE:

FIGURE 3


Anchor
Shoe pivots
Secondary shoe
Primary shoe
Actuating force
Floating link

Used with permission of EIS Corporation.

OBJECTIVE 2

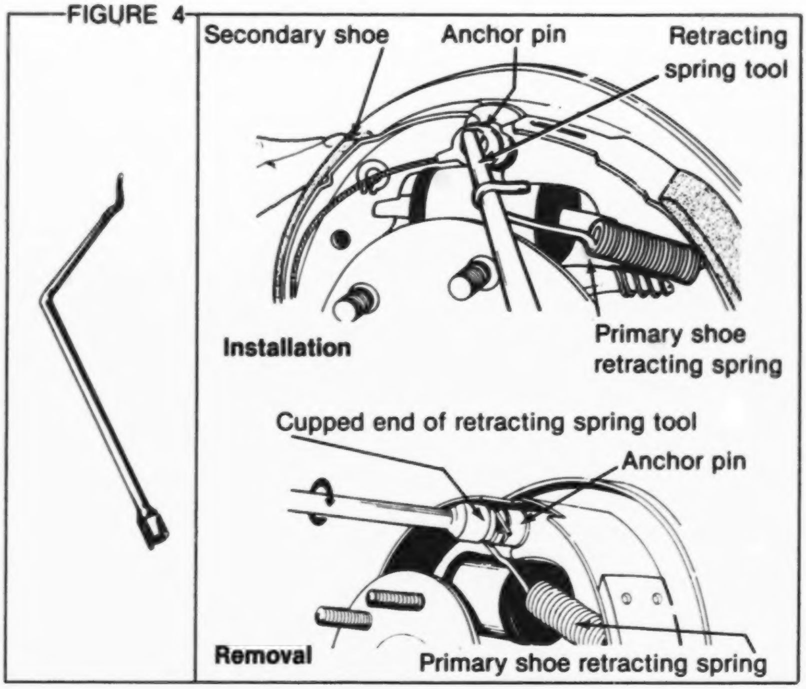
Recall uses of specialty tools used to service drum brakes

Retracting spring (brake spring) tool — Used to pry springs off anchor pin for removal and to stretch springs over anchor pin for reinstallation (Figure 4)

NOTE: Note that each end of the tool is designed for a specific function. The pointed end is used for reinstallation of spring and the cupped end is used for removal.

EXAMPLE:

FIGURE 4


Secondary shoe
Anchor pin
Retracting spring tool
Installation
Primary shoe retracting spring
Cupped end of retracting spring tool
Anchor pin
Removal
Primary shoe retracting spring

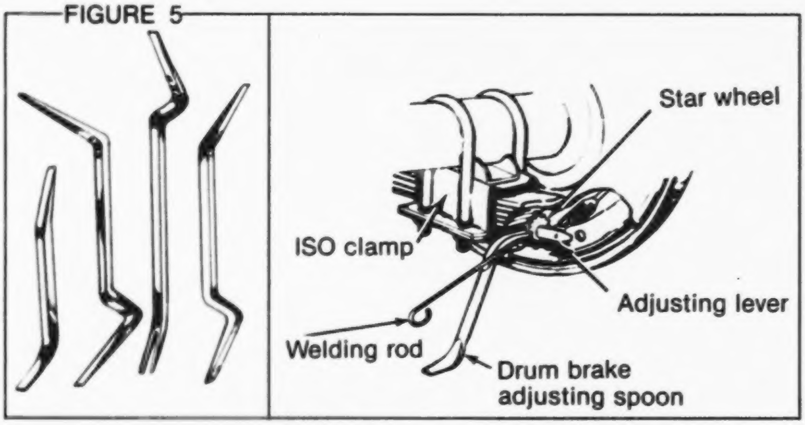
From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Drum brake adjusting spoon — Used to back off star wheel for drum removal or for adjustment of lining-to-drum clearance (See Figure 5)

NOTE: The tools shown in Figure 5 vary slightly for different makes and models of automobiles.

EXAMPLE:

FIGURE 5


Star wheel
ISO clamp
Adjusting lever
Welding rod
Drum brake adjusting spoon

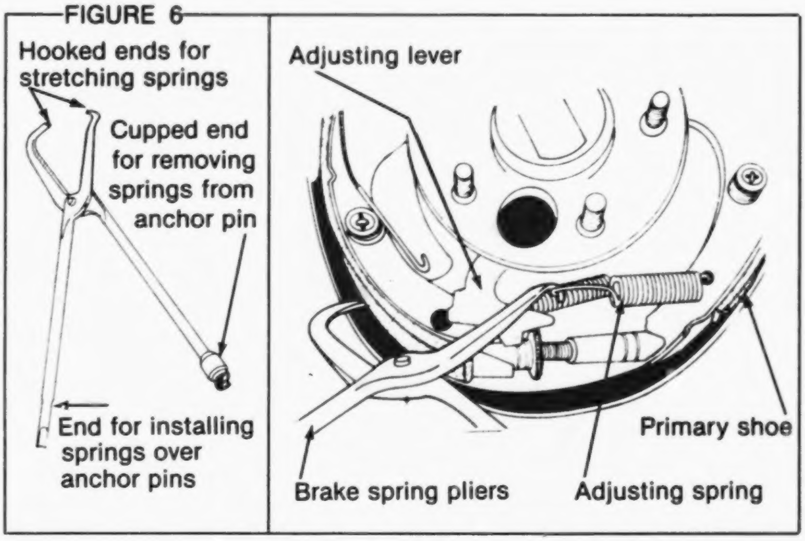
Used with permission of Chrysler Corporation.

Brake spring pliers — Used to remove and reinstall retracting and adjusting springs (Figure 6)

NOTE: This tool is a variation of the brake spring tool shown in Figure 4. Note that the end of one handle is adapted for removal and the other for reinstallation. The pliers have hooked ends that allow the technician to grasp and stretch the spring.

EXAMPLE:

FIGURE 6

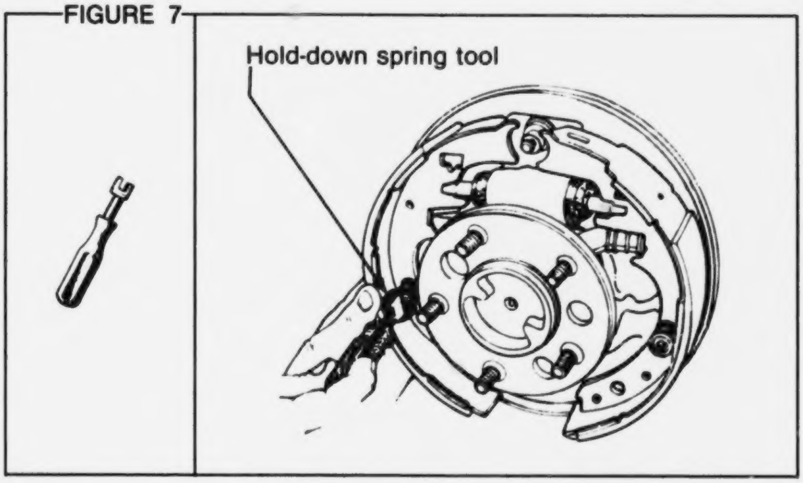

Hooked ends for stretching springs
Cupped end for removing springs from anchor pin
End for installing springs over anchor pins
Adjusting lever
Primary shoe
Brake spring pliers
Adjusting spring

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Hold-down spring tool — Used to remove and reinstall hold-down springs (Figure 7)

EXAMPLE:

FIGURE 7

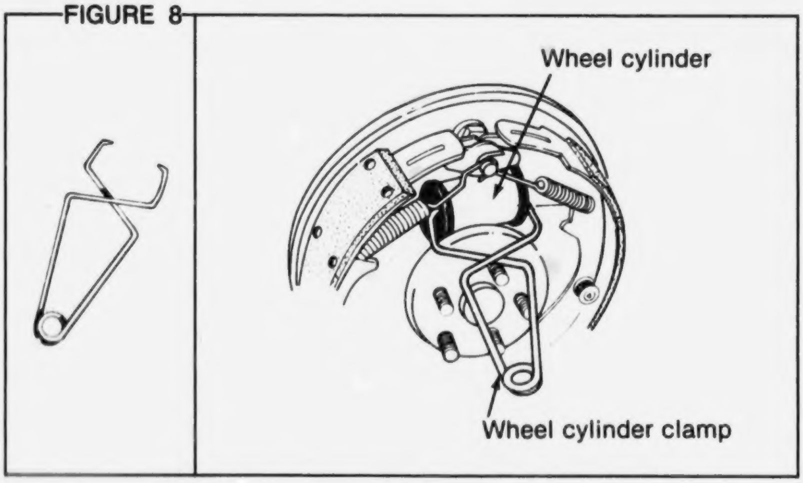


Used with permission of Chrysler Corporation.

Wheel cylinder clamp — Used to prevent hydraulic pressure from pushing wheel cylinder pistons and cups too far out in bore when brake shoe retracting springs are removed (Figure 8)

EXAMPLE:

FIGURE 8



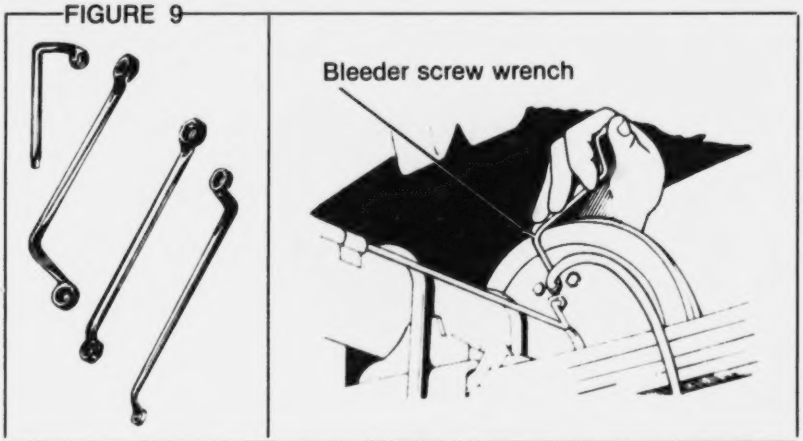
From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Bleeder screw wrench — Used to open and close wheel cylinder bleeder screws (Figure 9)

NOTE: Note the design variations in the bleeder wrenches illustrated in Figure 9. One is a right-angle wrench, others have offset heads, and still others are designed for specific makes and models of automobiles.

EXAMPLE:

FIGURE 9

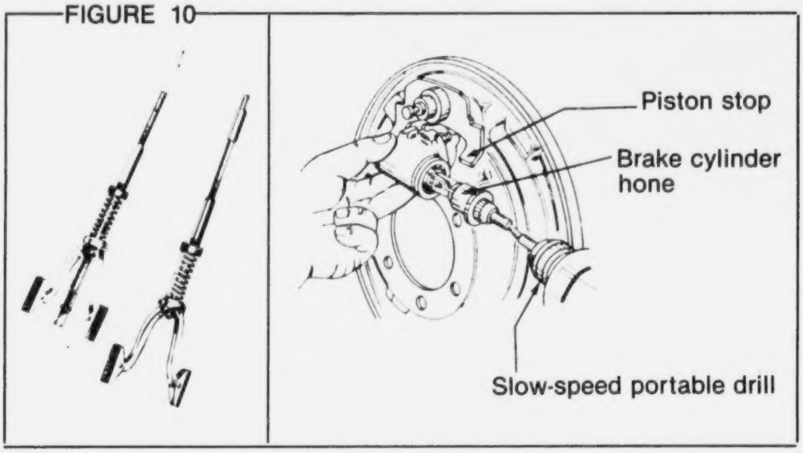

Bleeder screw wrench

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Brake cylinder hone — Used to recondition wheel cylinder bore (Figure 10)

EXAMPLE:

FIGURE 10

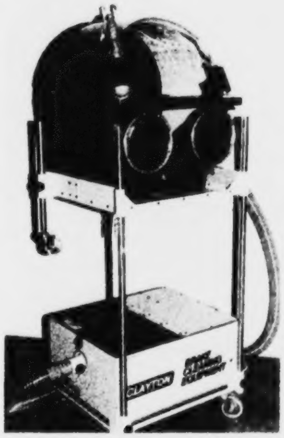

Piston stop
Brake cylinder hone
Slow-speed portable drill

Used with permission of Wagner Division, Cooper Industries, Inc.

Enclosure-type brake cleaner — Used to clean brake lining dust from brake assembly; designed to protect technician from harmful asbestos fibers (Figure 11)

EXAMPLE:

FIGURE 11

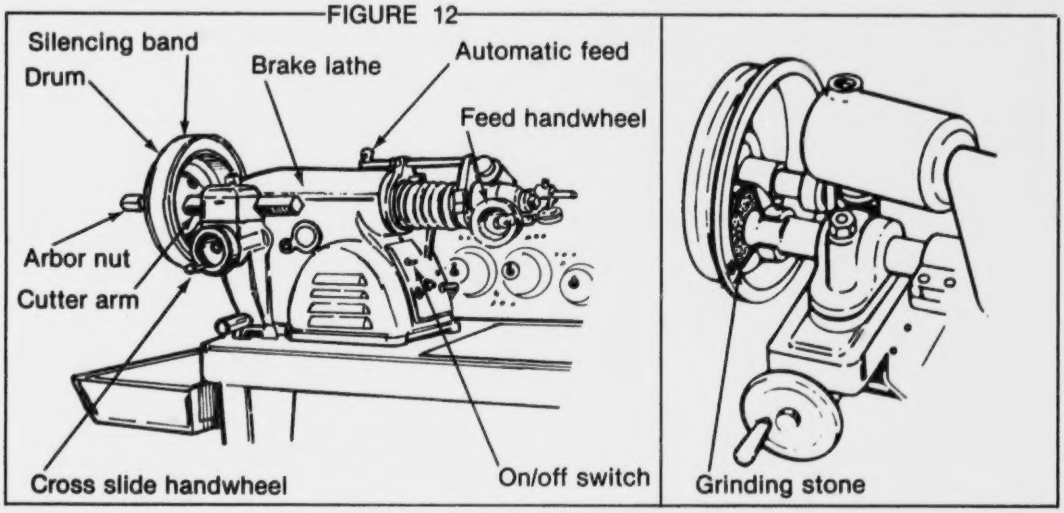


Courtesy of Clayton Associates, Inc.

Drum brake lathe — Used to machine friction surface of brake drums and to grind out hardened areas on drum (Figure 12)

EXAMPLE:

FIGURE 12


Silencing band
Drum
Brake lathe
Automatic feed
Feed handwheel
Arbor nut
Cutter arm
Cross slide handwheel
On/off switch
Grinding stone

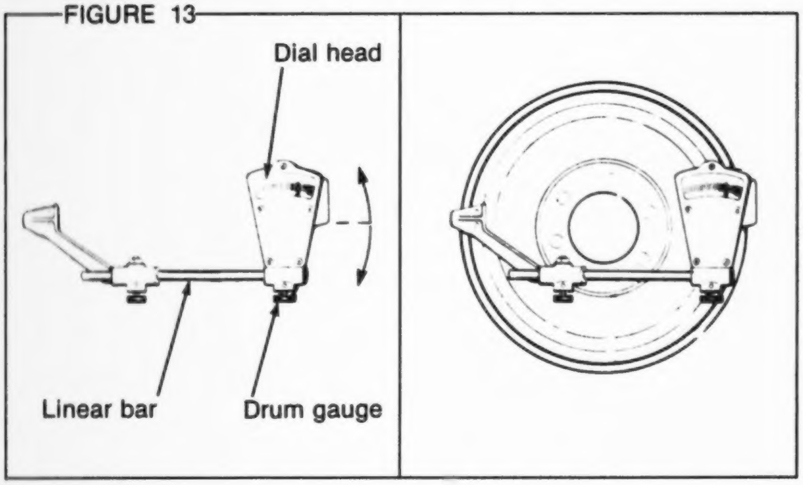
Used with permission of EIS Corporation.

Used with permission of Wagner Division, Cooper Industries, Inc.

Brake drum micrometer — Used to measure drum diameter (Figure 13)

EXAMPLE:

FIGURE 13

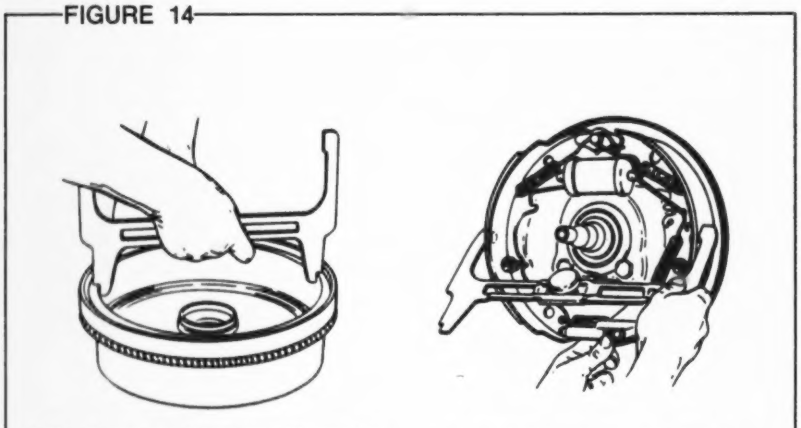


Used with permission of Wagner Division, Cooper Industries, Inc.

Drum-to-shoe gauge — Used to measure and adjust lining-to-drum clearance (Figure 14)

EXAMPLE:

FIGURE 14



Adjust gauge to drum diameter.

Adjust shoes to fit gauge.

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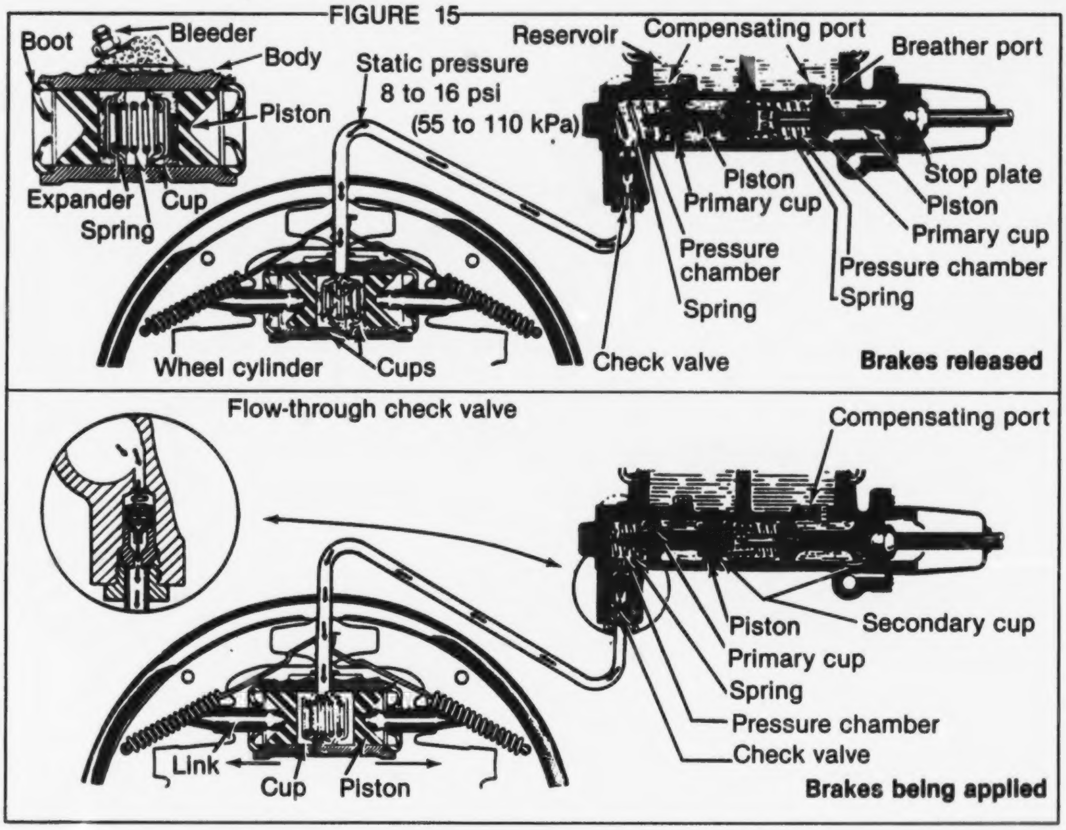
OBJECTIVE 3 Recall steps in drum brake operations

1. Brake pedal is depressed, generating hydraulic pressure in master cylinder
2. Hydraulic pressure from master cylinder is transmitted to wheel cylinder
3. Wheel cylinder pistons push brake shoes against rotating drum
4. Shoes try to rotate with drum, producing a wedging action that helps press the linings into firmer contact with drum

   NOTE: This self-energizing action supplements hydraulic effort, increasing friction and improving stopping ability.
5. Friction between brake shoe and brake drum slows or stops rotation of wheel

   EXAMPLE:

FIGURE 15


Boot
Bleeder
Body
Piston
Expander
Cup
Spring
Static pressure
8 to 16 psi
(55 to 110 kPa)
Reservoir
Compensating port
Breather port
Piston
Primary cup
Stop plate
Piston
Primary cup
Pressure chamber
Pressure chamber
Spring
Spring
Wheel cylinder
Cups
Check valve
Brakes released
Flow-through check valve
Compensating port
Piston
Secondary cup
Primary cup
Spring
Pressure chamber
Check valve
Link
Cup
Piston
Brakes being applied

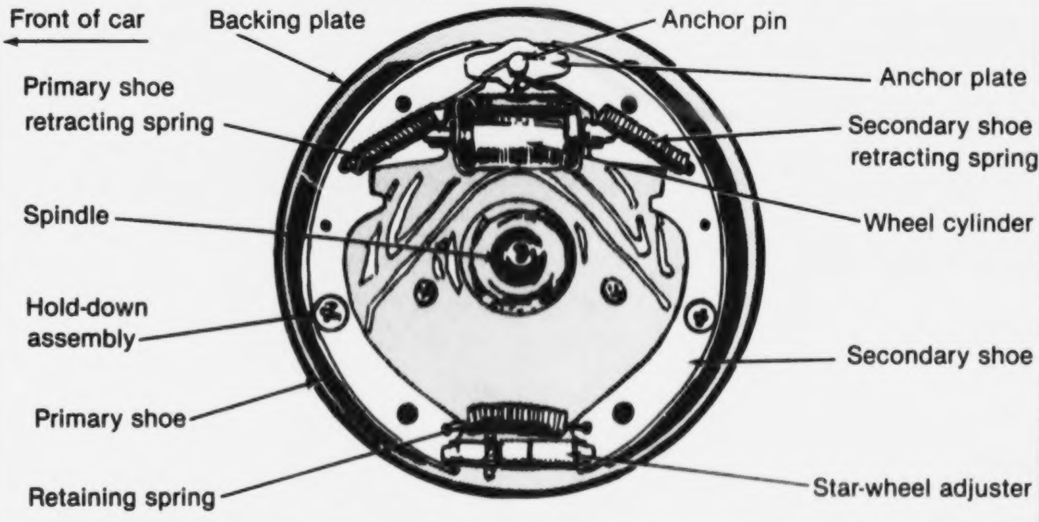
Used with permission of General Motors Corporation, Buick Motor Division.

OBJECTIVE 4

Recall components of typical duo-servo and non-servo brake assemblies

- Duo-servo brake assembly (Figure 16)

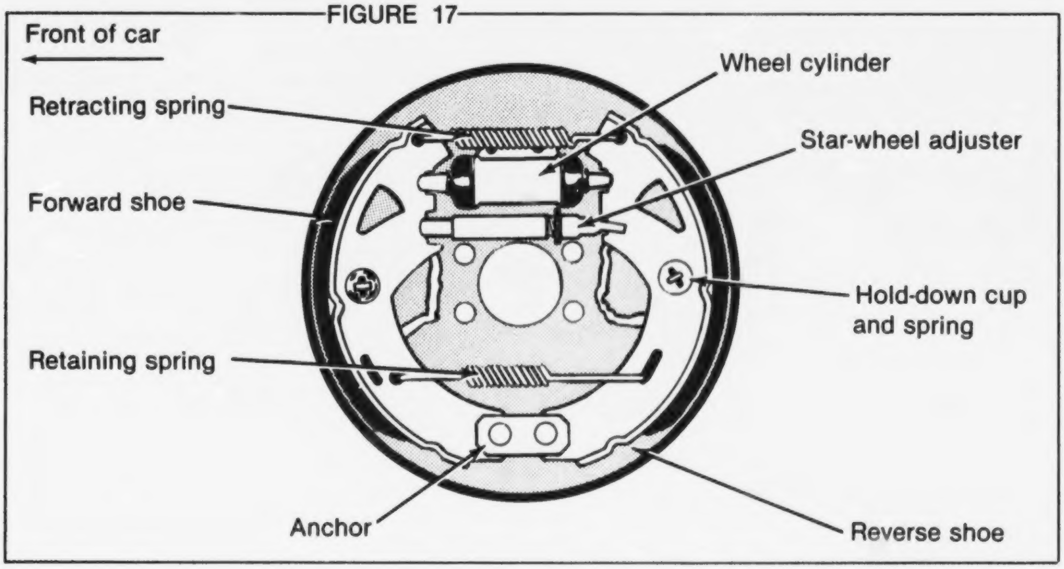
FIGURE 16


Front of car
Backing plate
Anchor pin
Anchor plate
Primary shoe retracting spring
Secondary shoe retracting spring
Spindle
Wheel cylinder
Hold-down assembly
Secondary shoe
Primary shoe
Retaining spring
Star-wheel adjuster

Adapted with permission of Raybestos/Brakes Systems, Inc.

- Non-servo brake assembly (Figure 17)

FIGURE 17


Front of car
Wheel cylinder
Retracting spring
Star-wheel adjuster
Forward shoe
Hold-down cup and spring
Retaining spring
Anchor
Reverse shoe

OBJECTIVE 5

Recognize the functions of components of a duo-servo brake assembly

Backing plate — Holds all of the brake parts except the drum

Anchor pin — Prevents shoes from turning with the brake drum

Hold-down assembly — Holds shoes flat against backing plate

Retaining spring — Holds shoes together at star-wheel adjuster

Star-wheel adjuster — Pushes shoes farther apart as lining wears

Wheel cylinder — Pushes brake shoes out into contact with drum

Retracting spring — Pulls shoes away from drum when brakes are released

Brake shoe — Provides mounting surface for lining

Brake lining — Contacts drum and provides friction necessary for braking action

Servo Action

The servo brake design found on most vehicles contains two shoes, a *primary shoe* and a *secondary shoe*, which are held against the anchor pin until the wheel cylinder is pressurized. When the brakes are applied, the wheel cylinder pressure forces the tops of both shoes against the drum. Due to the rotation of the drum and the friction between the shoes and drum, the shoes rotate in the same direction. However, the secondary shoe cannot rotate because it is stopped by the anchor pin, but the primary shoe moves away from the anchor pin and transfers its force through the star wheel to the secondary shoe. Thus it "serves" the secondary shoe by pushing it against the drum with extra force. This action is called *servo* action.

When a vehicle is moving backward, the drum rotation is reversed and the function of the shoes is also reversed, the primary shoe being "served" by the secondary shoe. When servo action is provided in both directions, the brake is called *duo-servo*.

In non-servo brakes, each shoe is separately anchored at the bottom, and their action is not compounded. Because of this difference in operation, non-servo brake shoes are called *forward* or *leading* shoes and *reverse* or *trailing* shoes. The leading shoe is self-energized by the usual drum rotation, and the reverse shoe is deenergized. The self-energizing action is reversed when the drum is rotated backwards.

OBJECTIVE 6

Recognize definitions of terms associated with brake drum problems

Carbonizing — Severe overheating of an object resulting in a change of the material content

NOTE: This process is called *carbonizing* because the material left is usually a carbon material such as ash or carbon scorching.

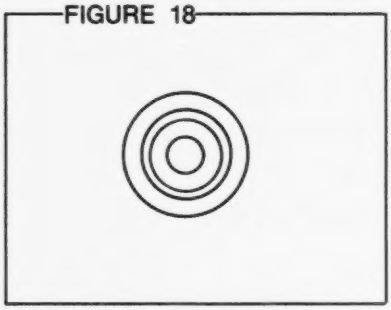
Concave — Curved inward

Convex — Curved outward

Concentric — Having a common center (Figure 18)

EXAMPLE:

FIGURE 18



Deflection — Turned or bent to one side

Distorted — Twisted out of shape or changed from usual or normal shape

Eccentric — Not having a common center; out-of-round

Fade — Loss of braking friction caused by excessive heat

Galling — Forcing material out of its regular shape or condition by high-pressure rubbing

Glazed — Having shiny, glass-hard resin deposits on surface

Wallowed — Having enlarged or misshapen hole due to wear or rubbing

Warpage — Condition of no longer being perfectly round or true

OBJECTIVE 7

Recall defects to look for when visually inspecting drum brake components

TABLE 1 — Drum brake component defects

Component	Defects
Brake lining	• Cracks • Glazing • Fluid or grease contamination • Uneven wear
Drum	• Hot spots • Scoring • Cracking • Out-of-round • Oversize
Backing plates	• Cracks and warpage • Pads for ridges • Pads for steps • Lack of lubrication
Shoe retainer and spring nail assemblies	• Wallowing of retainer holes • Loose springs • Improper installation of spring nails or retainers
Retaining springs	• Overheating • Stretching • Distortion • Nicks
Automatic adjuster assemblies	• Missing or damaged parts • Improper installation • Frayed adjusting cables • Rounded-off star wheels • Damaged cable guides • Damaged adjusting levers • Frozen adjusting screws

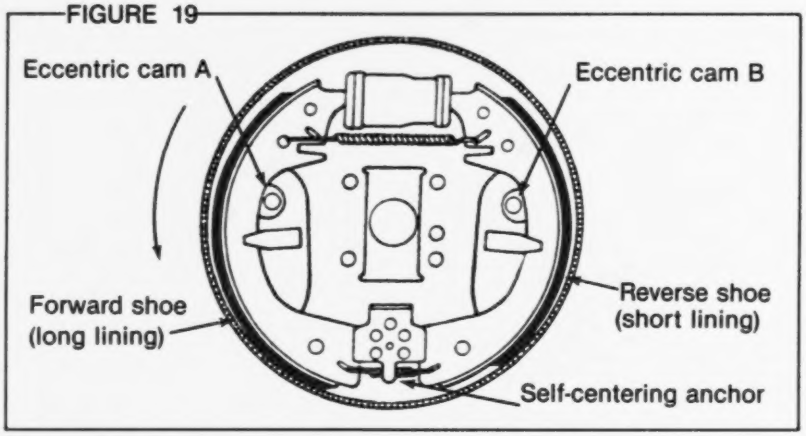
OBJECTIVE 10

Recall common types of brake shoe mountings

- Single-anchor self-centering (Figure 19)

  NOTE: This brake anchoring design provides no servo action, but the primary shoe is self-energizing. It is also self-centering because the shoe anchor does not fix the location of the shoes in any specific relationship to the drum. The shoes can move up or down until centered. One rarely used mounting includes a combination anchor pin and eccentric/anchor adjuster in each shoe rather than one self-centering anchor.

FIGURE 19

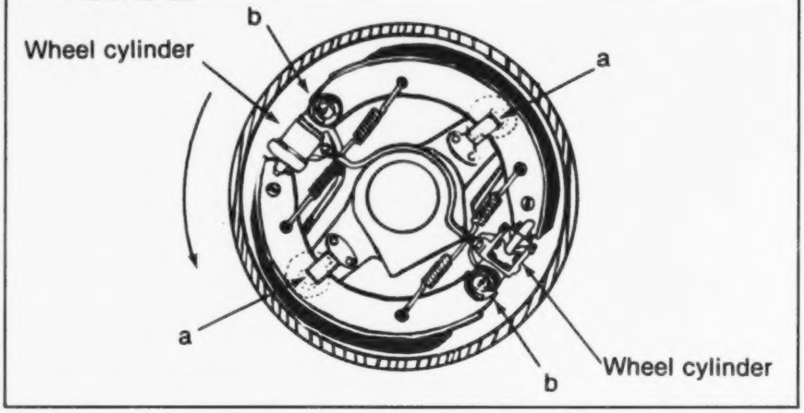

Eccentric cam A
Eccentric cam B
Forward shoe
(long lining)
Reverse shoe
(short lining)
Self-centering anchor

Used with permission of Raybestos/Brake Systems, Inc.

- Double-anchor double-cylinder (Figure 20)

  NOTE: In this design, the free end of each shoe is actuated toward the direction of rotation, and both shoes are self-energizing. Two single-piston cylinders are used. Brake adjustment is provided by eccentrics—(a) in illustration—and the anchors (b) are also eccentrics so that the shoes may be centered in relationship to the drum.

FIGURE 20


b
Wheel cylinder
a
a
b
Wheel cylinder

Used with permission of Raybestos/Brake Systems, Inc.

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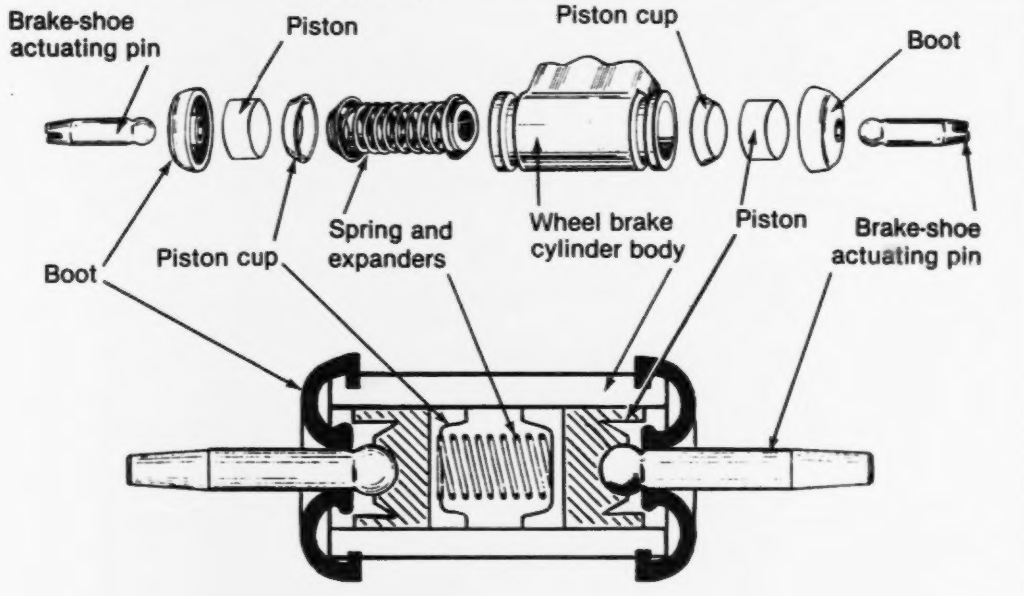
OBJECTIVE 12 | Recall basic components of a typical wheel cylinder

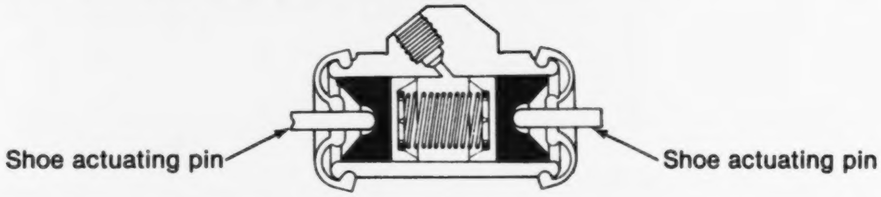
FIGURE 21


Brake-shoe actuating pin
Piston
Piston cup
Boot
Boot
Piston cup
Spring and expanders
Wheel brake cylinder body
Piston
Brake-shoe actuating pin

Adapted with permission of McGraw-Hill Book Company, Gregg Division, from *Automotive Mechanics*, 8th ed., by William H. Crouse, 1980.

Wheel Cylinder Operation

Wheel cylinders operate on basic hydraulic principles. The space in the cylinder bore between the cups must remain filled with fluid at all times. When the brake pedal is depressed, additional brake fluid is forced into the cylinder bore. The additional fluid, which is under pressure, moves the cups and pistons outward in the bore as shown below. This piston movement forces the shoe actuating pins and brake shoes outward to contact the drum and thus apply the brakes. On some brakes, the end of the shoe web bears directly against the pistons, and shoe actuating pins are not used.


Shoe actuating pin
Shoe actuating pin

Adapted with permission of Allied Aftermarket.

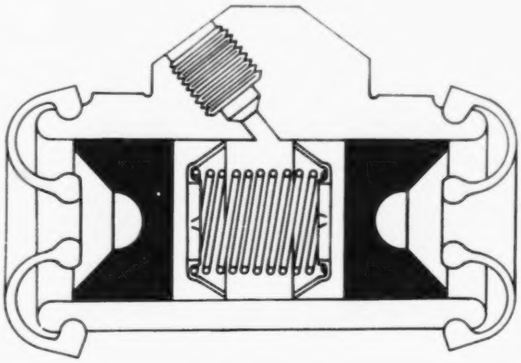
OBJECTIVE 13

Recall types of wheel cylinders used with drum brakes

- Double-piston straight-bore

NOTE: The double-piston straight-bore wheel cylinder is the type most commonly used on modern automobile brakes.

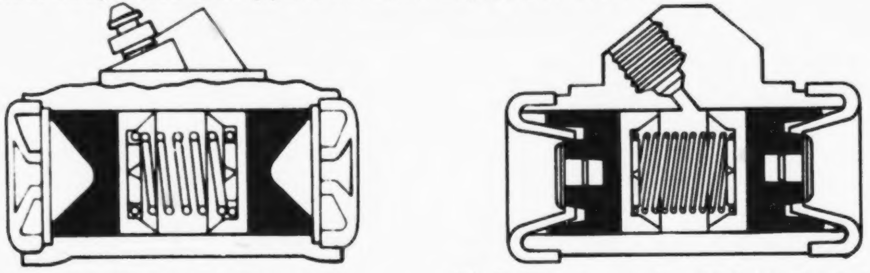
FIGURE 22



Used with permission of Allied Aftermarket.

Design Variations

Double-piston straight-bore wheel cylinder designs may vary in the method of attaching the dust boots to the cylinder body. Illustration (a) below shows boots fitted inside the end of the cylinder body. Illustration (b) shows external press-on boots.



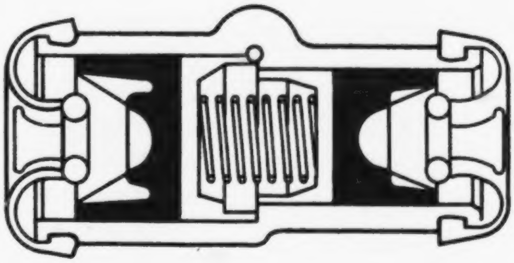
(a) Boots fit inside ends of cylinder body.

(b) Boots are pressed over outside of cylinder body.

Illustrations (a) and (b) used with permission of Allied Aftermarket.

- Double-piston step-bore (Figure 23)

FIGURE 23

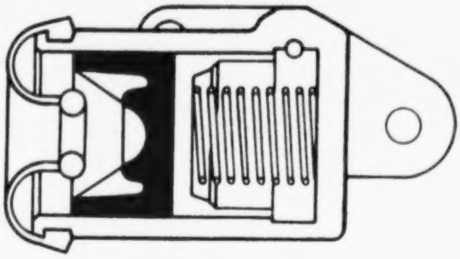


Used with permission of Allied Aftermarket.

- Single-piston (Figure 24)

  NOTE: Single-piston wheel cylinders may be fixed (generally used in pairs), floating (used mostly on imported vehicles), or sliding (used on some imports). Figure 24 shoes a single-piston fixed design.

FIGURE 24



Used with permission of Allied Aftermarket.

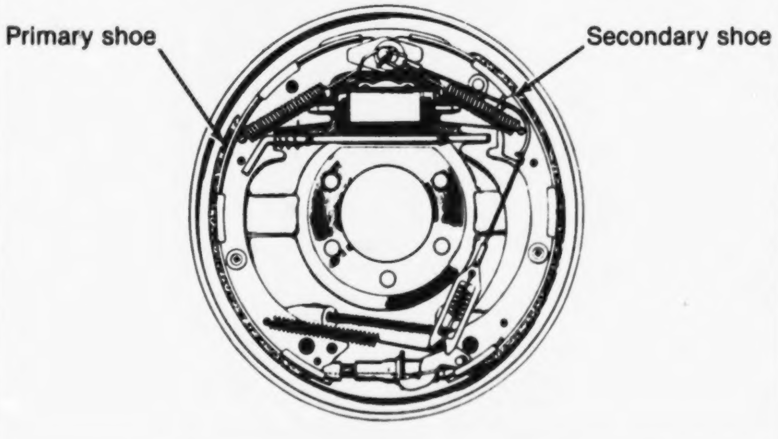
OBJECTIVE 15

Recognize types of automatic drum brake shoe adjusters

- Cable (Figures 25 and 26)

NOTE: As shoe travel outward increases with lining wear, a cable pulls the adjuster lever up enough to engage the next tooth on the star wheel when brakes are applied in reverse.

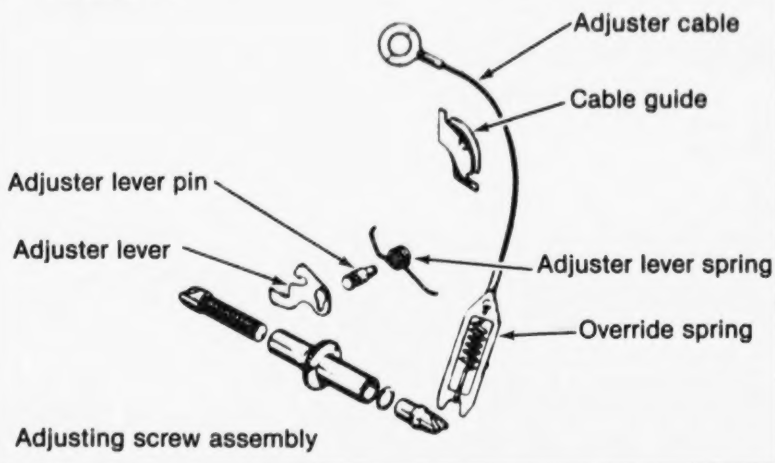
FIGURE 25


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

EXAMPLE: Automatic adjuster parts

FIGURE 26


Adjuster cable
Cable guide
Adjuster lever pin
Adjuster lever
Adjuster lever spring
Override spring
Adjusting screw assembly

Used with permission of Allied Aftermarket.

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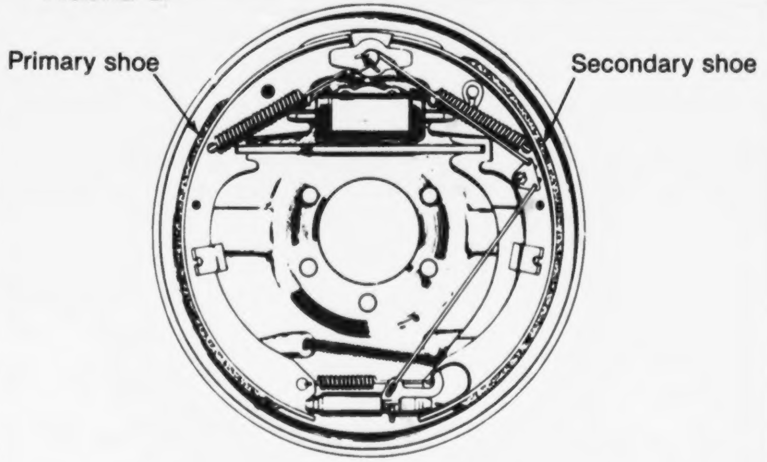
- Link (crank) (Figures 27 and 28)

NOTE: The link- or crank-type adjuster operates in the same manner as the cable-type automatic adjuster; except the adjuster lever is actuated with a link or wire when brakes are applied in reverse.

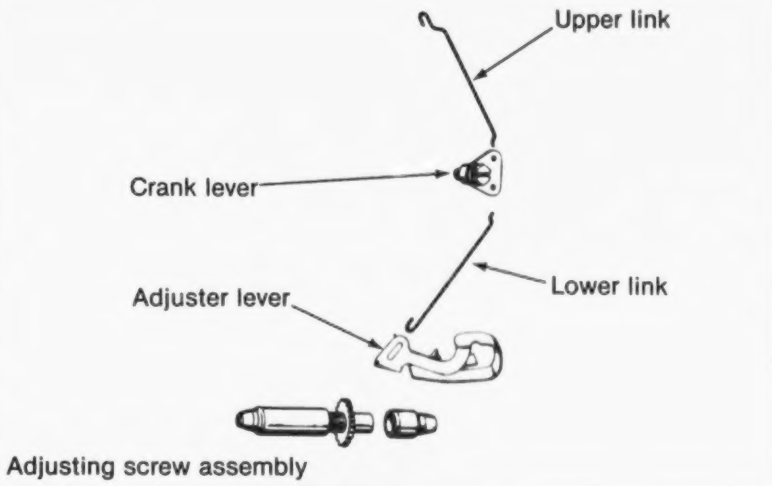
FIGURE 27


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

EXAMPLE: Automatic adjuster parts

FIGURE 28

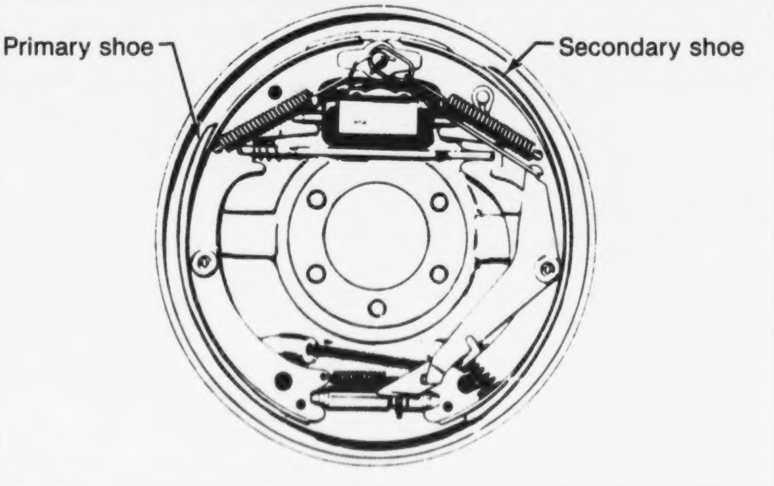

Upper link
Crank lever
Lower link
Adjuster lever
Adjusting screw assembly

Used with permission of Allied Aftermarket.

- Lever (Figures 29 and 30)

NOTE: In this design, a one- or two-piece lever is attached to the brake shoe and pivots as lining wears to engage a pawl in the star-wheel teeth. The two-piece lever is an earlier design.

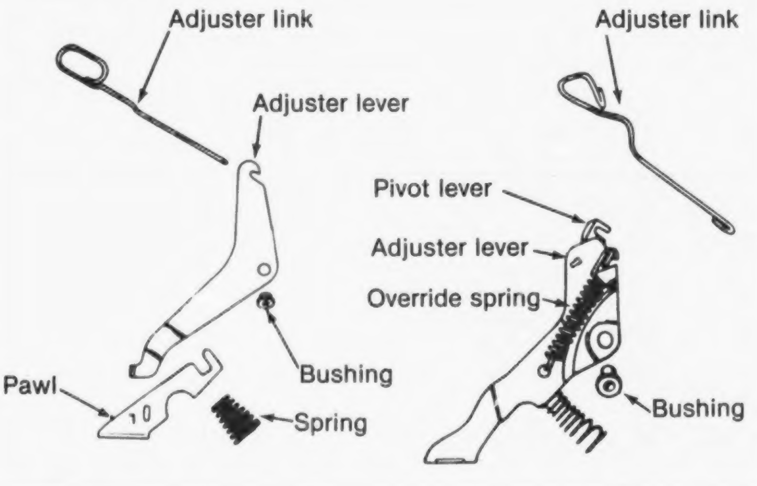
FIGURE 29


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

EXAMPLE: Automatic adjuster parts

FIGURE 30


Adjuster link
Adjuster link
Adjuster lever
Pivot lever
Adjuster lever
Override spring
Bushing
Pawl
Spring
Bushing

Used with permission of Allied Aftermarket.

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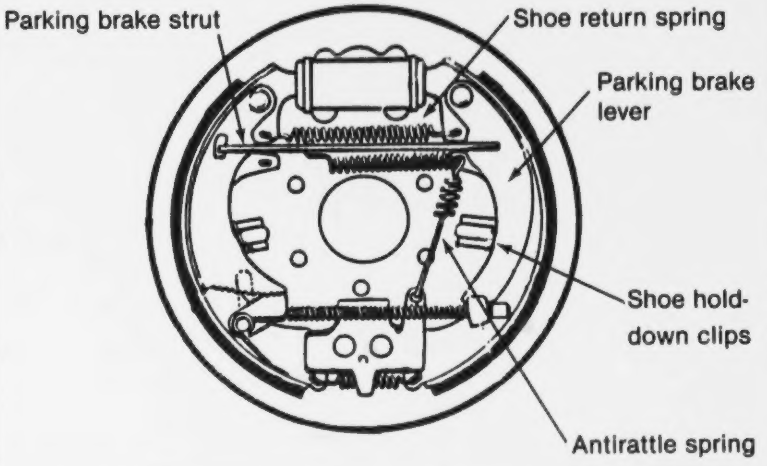
- Ratchet (Figures 31 and 32)

  NOTE: This adjuster has an automatic adjuster lever (large ratchet) and a smaller lever (small ratchet), both of which have interlocking teeth. As the lining wears, the large ratchet must pivot farther and catch the next tooth on the smaller ratchet, thus adjusting shoes to proper clearance.

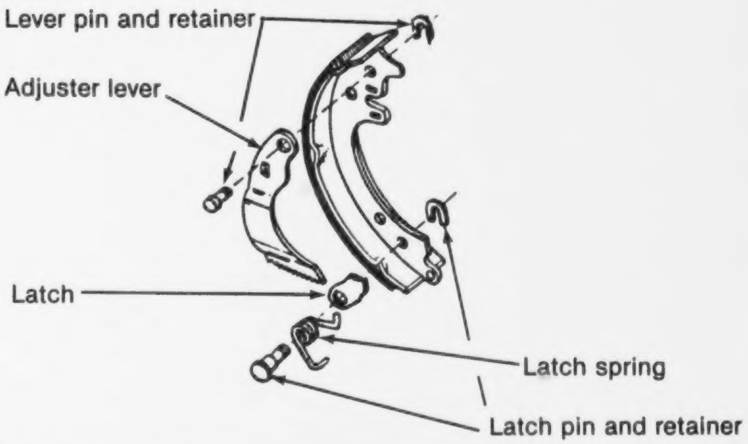
FIGURE 31


Parking brake strut
Shoe return spring
Parking brake lever
Shoe hold-down clips
Antirattle spring

Used with permission of Ford Motor Company.

EXAMPLE: Automatic adjuster parts

FIGURE 32

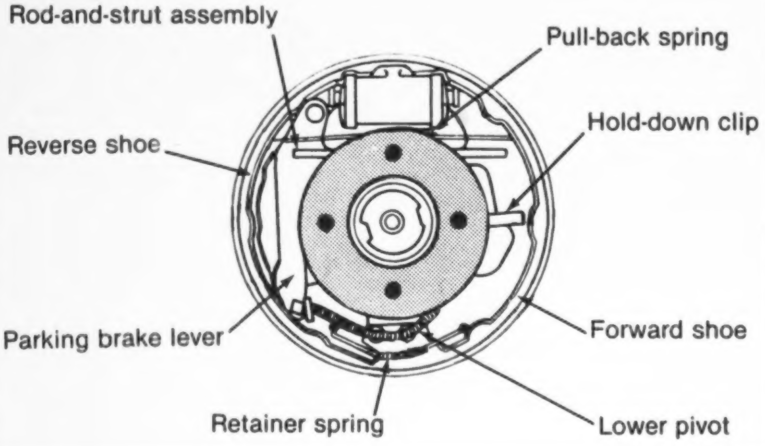

Lever pin and retainer
Adjuster lever
Latch
Latch spring
Latch pin and retainer

Used with permission of Ford Motor Company.

- Rod-and-strut assembly (Figures 33 and 34)

  NOTE: Adjustment with this type of adjuster occurs only with parking brake operation. Upon use of the parking brake, the strut engages the forward shoe against the brake drum. As the shoes pull apart, the rod pulls the spring-lock assembly to lengthen the strut. It is recommended that new adjuster assemblies of this type be installed with shoe replacement. Adjusters are not interchangeable from side to side of the vehicle.

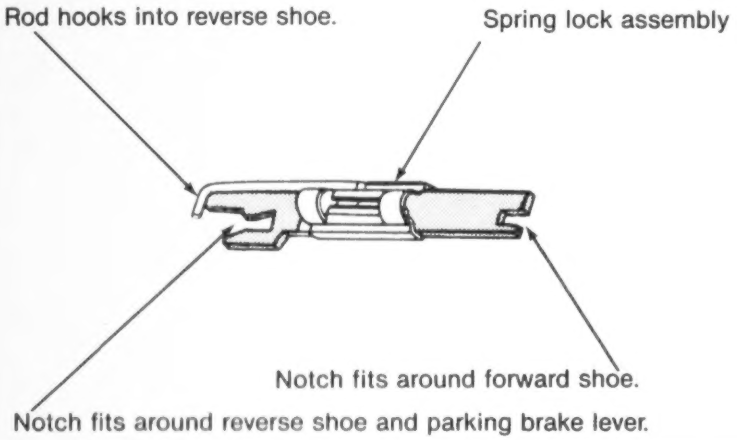
FIGURE 33


Rod-and-strut assembly
Pull-back spring
Hold-down clip
Reverse shoe
Parking brake lever
Forward shoe
Retainer spring
Lower pivot

Used with permission of Allied Aftermarket.

EXAMPLE: Automatic adjuster parts

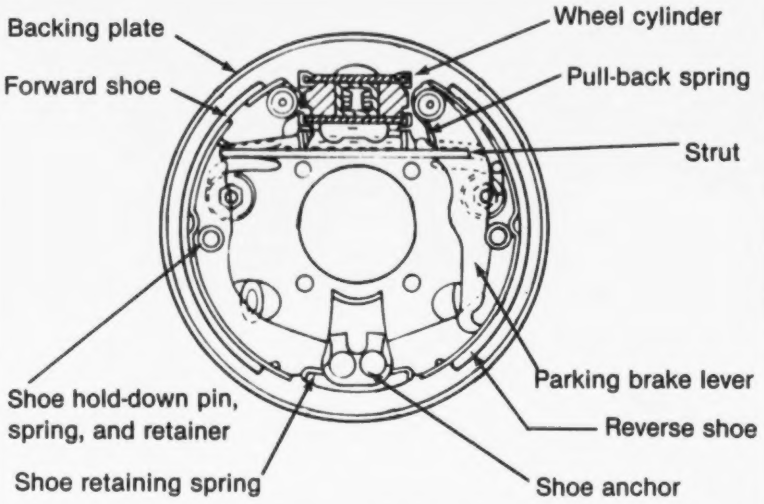
FIGURE 34


Rod hooks into reverse shoe.
Spring lock assembly
Notch fits around forward shoe.
Notch fits around reverse shoe and parking brake lever.

Used with permission of Allied Aftermarket.

- Eccentric cam (Figures 35 and 36)

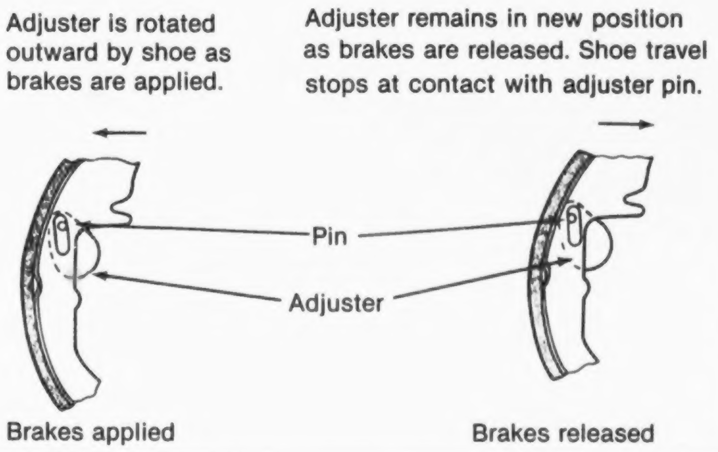
FIGURE 35


Backing plate
Forward shoe
Wheel cylinder
Pull-back spring
Strut
Parking brake lever
Reverse shoe
Shoe hold-down pin, spring, and retainer
Shoe retaining spring
Shoe anchor

Used with permission of Allied Aftermarket.

EXAMPLE:

FIGURE 36


Adjuster is rotated outward by shoe as brakes are applied.
Adjuster remains in new position as brakes are released. Shoe travel stops at contact with adjuster pin.
Pin
Adjuster
Brakes applied
Brakes released

Used with permission of Allied Aftermarket.

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STUDENT SUPPLEMENTS

SERVICE DRUM BRAKES

SUPPLEMENT 1

Troubleshooting Chart for Drum Brakes

NOTE: Conditions caused by brake systems and wheel bearings are described in the following chart; however, similar indications may result from steering and suspension problems.

Condition	Probable cause	Corrective action
Low pedal (lack of reserve; pedal height increased by "pumping"; pedal goes to floor)	Low fluid level permits air to enter system	Refill and bleed master cylinder
	Leak in the hydraulic system	Check master cylinder, wheel cylinders, brake lines, and hoses for leakage; repair or replace faulty parts
	Improper adjusted master cylinder or power brake pushrod	Adjust pushrod free play
	Excessive clearance between drums and linings	Adjust the brakes
	Brakes out of adjustment	If automatically adjusted, make several forward and reverse stops, or set and reset the parking brake, whichever actuates the automatic adjuster; if pedal does not come up, repair the automatic adjuster. On star-wheel-type, check the pawl advancement. If manually adjusted, adjust as needed; repair and replace adjusters as needed
	Bent or distorted brake shoes	Replace shoes and linings in axle sets only
Pedal pulsation (pedal chatter, fight, or vibration while braking)	Worn or damaged front wheel bearings	Replace bearings
	Out-of-round drums	Recondition or replace drums in axle sets
	Bent rear axle	Replace axle
	Loose backing plate	Tighten to specifications
	Bent backing plate	Replace backing plate
	Excessive drum runout due to faulty installation of new drums	Remove and properly install the drums

Condition	Probable cause	Corrective action
Spongy or springy pedal	Air in brake system	Refill and bleed; check for possible fluid leaks at • master cylinder secondary cup • wheel cylinders or disc calipers • hose and line connections • power brake vacuum line; disconnect vacuum line and check for presence of fluid
	Fluid boil, vaporized by overheating	Check by opening bleeder screw; bleed system **CAUTION** Cooling will restore braking, but condition will return when brakes are heated. Drain and replace fluid; check for cause of boiling: • fluid contaminated or wrong type for system • overheated brakes caused by thin drums, spotty lining contacts, severe overloading of vehicle Correct accordingly
	Loss of system residual pressure, permitting air to seep into wheel cylinders	Replace residual pressure check valve
	Improper use of parking brake (after pedal is released), causing a pressure loss	Set parking brake before releasing pedal
	Shoes bent, distorted, or not centered in drum	Replace shoes and linings in axle sets; adjust anchor pins (if provided); check lining seating and drum eccentricity
	Brake drum too thin	Replace drums in axle sets

Condition	Probable cause	Corrective action
Hard pedal (excessive stopping distance and/or effort required to stop vehicle)	After extended use, linings worn out or poor quality brake linings	Replace with approved shoes and linings in axle sets only
	"Faded" overheated condition, glazed linings, "blued" or heat-checked drums	Lightly sand lining surface or replace shoes and linings in axle sets; recondition or replace drums
	Excessive lining clearance	Check and correct pawl or link advancement on automatic adjusters; adjust manual adjusters
	Grease-soaked or brake-fluid-soaked linings	Repair grease seal or wheel cylinder as necessary, and replace shoes and linings in axle sets only
	Low engine vacuum supply to power brake booster or defective power brake vacuum check valve	Tune or repair the engine to obtain correct vacuum, or replace check valve
	Faulty power brake booster	Replace power booster
	Loose or leaking vacuum hose to power brake booster	Tighten clamps or replace hose as required
	Wheel cylinder or master cylinder pistons stuck	Rebuild or replace appropriate cylinder
	Brake drum bell-mouthed or barrel-shaped	Refinish drum to proper limits, or replace (if beyond refinishing limits) in axle sets only

Condition	Probable cause	Corrective action
Brakes drag, lock or overheat	Rough or corroded master cylinder bore; master cylinder bypass port blocked by dirt or swollen primary cup	Rebuild or replace master cylinder **NOTE:** Do **not** rebuild aluminum master cylinders.
	Binding brake pedal linkage; bind prevents the return of pedal against its stop	Free up and lubricate
	Weak pedal return spring	Replace spring
	Valve leaks, weak reaction springs, or bind in power mechanism	Repair or replace power section of power brake
	Loose or worn front wheel bearings	Adjust to specifications or replace
	Defective brake hose or lines preventing return of brake fluid	Replace faulty lines or hoses
	Soft or swollen rubber parts caused by contaminated or incorrect brake fluid	Replace all rubber parts (including hoses), flush hydraulic system, and fill with approved brake fluid
	Incorrect, bent, or distorted shoes	Replace shoes and linings in axle sets
	Weak or broken shoe return springs	Replace shoe return springs
	Incorrect linings, linings loose on shoes, or grease or brake fluid on linings	Replace with correct shoes and linings in axle sets only; repair grease seal or wheel cylinders
	Improper brake shoe adjustment	Adjust shoes and repair automatic adjuster if necessary
	Shoes not centered in drums	Adjust anchor pin if provided
	Loose or distorted brake backing plate	Tighten or replace backing plate
	Scored, hot-spotted, or out-of-round drums	Refinish drums or replace in axle sets
	Frozen parking brake cables	Free up and lubricate cables or replace
	Piston stuck in wheel cylinder	Rebuild or replace wheel cylinder
	Plugged master cylinder vent port(s), and/or swollen or damaged master cylinder primary cups	Rebuild or replace master cylinder; flush hydraulic system and fill with approved brake fluid **NOTE:** Do **not** rebuild aluminum master cylinders.

Condition	Probable cause	Corrective action
Severe stops, dive (brakes sensitive to light pedal effort, excessive wheel skid)	Unbalanced "pull," any condition causing brake to grab	Refer to next section "Car pulls to one side"
	Abnormal front-end dive	
	• Front suspension wear or misalignment causing abnormal deflection, worn shocks, etc.	Align front end; repair or replace affected parts
	• Temporary morning sickness due to moisture or rust accumulation on cooled friction surfaces	No cause for worry if the conditions are temporary; if condition persists, repair affected parts
Car pulls to one side	Faulty suspension parts	Repair suspension system
	Incorrect linings on shoes	Replace with correct shoes and linings
	Brake fluid, oil, grease, mud, water, or dirt on linings	Repair grease seal or wheel cylinder as necessary; clean affected parts, replace shoes and linings in axle sets only
	Distorted or incorrect shoes	Replace with correct shoes and linings
	Shoes not centered in drums	Replace with correct shoes and linings
	Loose or distorted brake backing plate	Tighten or replace plate
	Weak shoe return springs or hold-downs	Replace with new parts
	Drum bell-mouthed, barrel-shaped, threaded, cracked, or containing high hard spots	Recondition or replace drums in axle sets
	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Abnormal deflection, wear and improper alignment including caster and camber, weak or broken springs, broken spring center bolt, loose U-bolts, loose steering gear or tie rods, worn shock absorbers, etc.	Check and correct front-end alignment; repair or replace faulty parts
	Faulty brake hose or obstruction in brake line	Replace hose or line
	Charred or badly worn brake linings	Replace linings (in axle sets) and other worn parts

Condition	Probable cause	Corrective action
Noises		
• **Squeal**	Improper arc grind or eccentric drum causes new lining to "pinch" against drum	Reface or grind drums, or regrind or replace linings in axle sets only
	Dust or other particles embedded in lining	Remove foreign matter; replace lining if necessary in axle sets only
	Loose lining rivets	Reset rivets or reline the shoes if rivet holes in lining are "wallowed"
	Loose backing plate, anchor, drum, or wheel cylinder	Tighten all loose parts or replace as necessary
	Shoes scrape on support pads	Clean and lubricate
	Weak or broken shoe hold-down springs	Replace springs
	Backing plate bent, shoes twisted	Replace plate and/or shoes
	Drums out-of-round or out-of-square	Recondition or replace drums in axle sets only
	Drum silencer (screen door) spring missing or weak	Replace spring
• **Grind**	Lining worn; rivets or shoe table rub on drum	Replace shoes and linings in axle sets; recondition or replace drums if damaged
	Foreign material embedded in lining	Replace shoes and linings in axle sets
	Rough drum surface	Recondition or replace drums in axle sets

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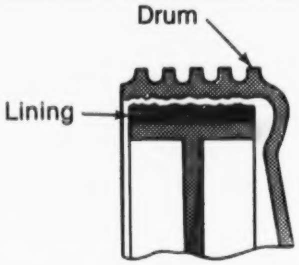
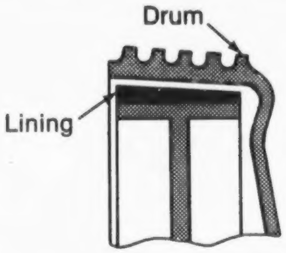
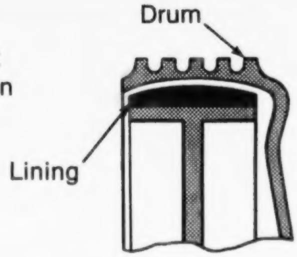
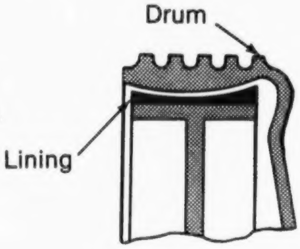
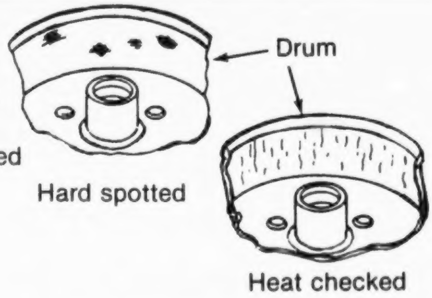
Condition	Probable cause	Corrective action
Noises (continued)		
• **Chatter**	Lining clearance too tight or too loose	Adjust linings to proper clearance
	Loose backing plate	Tighten or replace plate
	Grease, fluid, or dust on lining surface	Recondition or replace linings in axle sets
	Twisted brake shoe	Replace shoes
	Drum out-of-round, bell-mouthed, barrel-shaped, or cracked	Recondition or replace drum
	Weak or broken return spring	Replace springs
	Loose spindle and/or suspension parts	Adjust or replace as needed
	Improper lining grind	Replace linings in axle sets
• **Click (shoes lift off support pads and snap back)**	Threaded drum surface	Replace or recondition drum
	Weak hold-downs	Replace hold-downs
	Grooves in brake shoe support pads	Stone smooth and lubricate
• **Thumps/clunks**	Excessive lining clearance (applying, linings thump drums; releasing, shoes clunk on anchors)	Adjust brakes to proper clearance

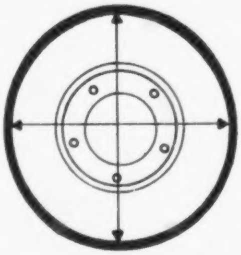
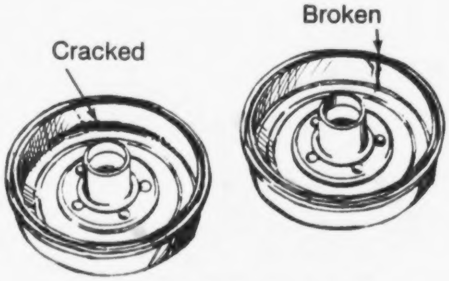
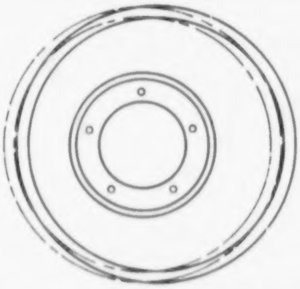
This student supplement is adapted from *Hydraulic Disc and Drum Brake Diagnostic and Reconditioning Manual, AU-1600/Feb., 1984,* by the Wagner Division, Cooper Industries, Inc.

SUPPLEMENT 2 Causes of Drum Brake Defects

NOTE: Brake drums provide the surface against which the linings are pressed to provide braking friction. Most drums are made of heavy cast iron or steel. They must be able to withstand high pressures without excessive flexing and must also dissipate large quantities of heat generated during brake application.

Defect	Cause	Example
Scored	Brake dust and dirt between brake lining and drum Glazed brake lining hardened by high heat Excessive lining wear exposing rivet head or shoe steel	 Used with permission of Allied Aftermarket.
Bell-mouthed	Extreme heat and braking pressures Oversized drums	 Used with permission of Allied Aftermarket.

Defect	Cause	Example
Barrel-shaped (concave)	Extreme braking pressure distorts shoe platform so that braking pressure wears pattern in center area of drum	 Used with permission of Allied Aftermarket.
Taper (convex)	Excessive heat or oversized drum causes greater wear pattern at closed end of drum and distorts open end of drum	 Used with permission of Allied Aftermarket.
Hard spotted/heat checked	Extreme operating temperatures create heat checks which are visible, or hard spots, which are not visible until drum is machined	 Used with permission of Allied Aftermarket.

Defect	Cause	Example
Out-of-round	Oversized drum Higher than normal operating temperatures Uneven shoe application Dragging parking brake	 Used with permission of Allied Aftermarket.
Cracked or broken	Wear and tear High operating temperature followed by rapid cooling Collison impact	 Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984*.
Eccentric (off center)	Application of parking brake when drums are overheated Improper lug nut torque Tightening lug nuts in improper sequence	 Reprinted by permission of John Wiley & Sons, Inc., from *Brakes*, 2nd ed., by John Remling, copyright © 1983 by John Wiley & Sons, Inc.

ASSIGNMENT SHEET 1

SERVICE DRUM BRAKES

OBJECTIVE 18

Diagnose drum brake problems

Name ______________________________ Score ________________

INTRODUCTION

Brake service is one of the most important and most common services performed in the automotive industry. State vehicle inspections are now required in most states, and an important part of that inspection is brake inspection. Therefore, vehicle owners need to have their vehicles' brakes periodically checked and repaired so their vehicles comply with state inspection standards. The normal wear and tear of everyday driving takes its toll on the vehicle's braking system. This means that the brakes specialist must be able to analyze customer complaints, inspect vehicle brake systems to locate problems, and ultimately diagnose the problems and repair them properly the first time.

DIRECTIONS

The following questions are multiple-choice-type questions, each with three possible answers. Read each question carefully and then select the answer that is *most* correct. Write the correct letters in the blanks. Refer to Student Supplements 1 and 2 if necessary.

_____1. A customer brings in a late-model automobile and complains that the pedal goes to the floor. Which of the following is the *most likely* cause?

a. Excessive drum expansion
b. Bent or distorted brake shoes
c. Weak or broken shoe return springs

_____2. When servicing a customer's vehicle, you find that the brake shoe support pads are grooved. Which of the following was the customer's complaint?

a. Squealing noise on brake application
b. Grinding noise on brake application
c. Clicking noise upon brake application

______3. You road test a vehicle to verify the customer's complaint that it pulls to the right. Upon inspection, you determine that this condition is caused by a sticking right wheel cylinder piston. Which of the following would be the proper corrective measure?

a. Repair or replace wheel cylinder
b. Lubricate piston with approved lubricant
c. Repair or replace piston

______4. Following up on a customer's complaint, you find that one of the brake hoses is obstructed. Which of the following was the customer's complaint?

a. Spongy or springy pedal
b. Pedal pulsation
c. Car pulls to one side

______5. A customer complains that she hears a thumping noise when she applies the brakes and a clunking noise when she releases the brakes. Which of the following do you explain to her as the *most likely* cause?

a. Shoes are lifting off the support pads and snapping back due to a threaded drum surface
b. Lining is worn causing the rivets to rub on the drum
c. Excessive lining clearance causes the linings to contact drums and shoes to contact anchors

______6. The customer complains of pedal pulsation. Which of the following is the *most likely* cause?

a. Brake drum bell-mouthed or barrel shaped
b. Brake drum too thin
c. Excessive drum runout

______7. When servicing a customer's vehicle, you find that the brake backing plate is bent. Which of the following would be the proper corrective measure?

a. Machine backing plate to recommended dimension
b. Replace backing plate
c. Adjust anchor pin (if provided)

_____8. When servicing a vehicle, you find that the linings are soaked with brake fluid. You repair the wheel cylinder and replace both shoes and linings in axle sets. Which of the following was the customer's complaint?

a. Excessive pedal pressure is required to stop the vehicle
b. Abnormal front-end dive
c. Pedal goes to the floor

_____9. When servicing a vehicle, you find that the brake shoes are improperly adjusted, causing the brakes to drag. Which of the following would be the proper corrective measure?

a. Replace shoe return springs
b. Adjust shoes and repair automatic adjuster if necessary
c. Adjust anchor pin (if provided)

_____10. The customer complains of a squealing noise upon brake application. Which of the following is the *most likely* cause?

a. Drum silencer spring missing or weak
b. Loose spindle and/or suspension parts
c. Weak hold-downs

_____11. When inspecting a vehicle, you find that the drum brake lining is scored. Which of the following is the *most likely* cause?

a. Oversized drums
b. Brake dust and dirt between brake lining and drum
c. Dragging parking brake

_____12. While performing a brake inspection, you find that the brake drums are cracked and broken. Which of the following is the *most likely* cause?

a. High operating temperature followed by rapid cooling
b. Excessive lining wear exposing rivet head or shoe steel
c. Uneven shoe application

_____13. Which of the following brake drum defects is caused by tightening lug nuts in the improper sequence?

a. Eccentric (off center)
b. Out-of-round
c. Barrel-shaped (concave)

_____14. When inspecting the brakes on a customer's vehicle, you find the brakes drums are out-of-round. Which of the following is the *most likely* cause?

a. Collision impact
b. Improper lug nut torque
c. Uneven shoe application

_____15. After machining a brake drum you notice hard spots are present on the drum. Which of the following is the *most likely* cause of this defect?

a. Excessive lining wear exposing rivet head or shoe steel
b. Extreme operating temperatures
c. Uneven shoe application

ASSIGNMENT ANSWERS

SERVICE DRUM BRAKES

ASSIGNMENT SHEET 1

1. b
2. c
3. a
4. c
5. c
6. c
7. b
8. a
9. b
10. a
11. b
12. a
13. a
14. c
15. b

ACTIVITY SHEETS

SERVICE DRUM BRAKES

ACTIVITY SHEET 1

Determine correct specialty tools to use to service drum brakes

Name ____

INTRODUCTION

To effectively and correctly service drum brakes, the brakes specialist must be able to identify the correct tools for the service situation and be able to use the tools correctly. There are a number of specialty tools that are designed for use when performing drum brake service, and these are listed and illustrated in Objective 2. The following problems will help you become familiar with the appropriate uses of these tools.

DIRECTIONS

Read each of the following situations. Then in the blanks below each, write the name of the correct tool that the brakes specialist should use in that situation.

1. A brakes specialist is servicing a wheel cylinder. She has removed the wheel cylinder and placed it in a vise and is now ready to recondition the cylinder bore. What tool would she use?

   ____

2. The specialist has finished service on a wheel cylinder and has reinstalled it and other related hardware. He now wants to open the wheel cylinder screws to bleed the system. What tool would he use?

   ____

3. The brakes specialist is removing, cleaning, and inspecting brake shoes, linings, and related hardware. He will not be rebuilding or replacing the wheel cylinder as part of the brake shoe replacement procedure. What tool must he use to prevent hydraulic pressure from pushing the wheel cylinder pistons and cups too far out in the bore when he removes the brake shoe retracting springs?

   ____

4. A brakes specialist is preparing to remove, clean, and visually inspect brake drums. What equipment must she install to clean brake lining dust from the drum assembly and to protect herself from asbestos contamination?

   ____

5. A brakes specialist is removing adjuster hardware from the drum brake backing plate. She is ready to remove the hold-down springs. What tools should she use?

____

6. A brakes specialist is ready to reassemble the shoes, linings, and related hardware on a drum brake backing plate. He must stretch the retracting springs over the anchor pin for reinstallation. Which tool should he use?

____

7. A brakes specialist has removed the drums from a vehicle. On inspection he finds that the drums are slightly scored. What tool must he use to correct this problem?

____

8. A brakes specialist finds that he needs to back off the star wheel for adjustment of lining-to-drum clearance. What tool would he use?

____

9. A specialist needs to remove and reinstall the retracting and adjusting springs on a drum brake assembly. What tool would she use?

____

10. A specialist has removed the drums from a vehicle and now needs to measure them to determine whether they are out-of-round. What tool would he use?

____

11. The specialist has removed, cleaned, and inspected brake shoes and related hardware. Now he has reassembled the assembly and needs to set drum-to-shoe clearance. What tool would he use?

____

ACTIVITY SHEETS

SERVICE DRUM BRAKES

ACTIVITY SHEET 2

Answer general questions about drum brakes

Name ______________________________

INTRODUCTION

To become certified as a brakes specialist, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence. The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only disc brakes, but contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

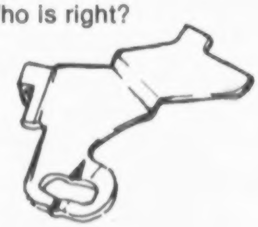
Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is *most* correct, and write its letter in the answer blank.

After you have completed this activity sheet, get together with a group of your classmates and use the answer key to check your answers. Each correct answer counts 4 points for a total score of 100 percent. Pay particular attention to those questions that you answered incorrectly. Do your incorrect answers indicate an area of weakness? Were these incorrect answers caused by carelessness or lack of knowledge. What steps must you take to improve your percentage of correct answers?
Discuss your answers with your group and with the class as a whole.

_____1. Technician A says that the part illustrated below is mounted on the primary brake shoe.

Technician B says that the part is mounted on the secondary brake shoe.

Who is right?



a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., © 1983, p. 7 (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

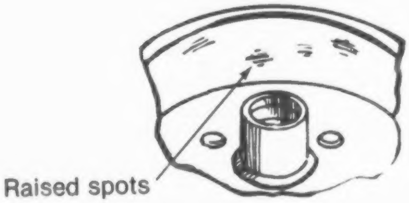
_____2. When turning a scored brake drum, the maximum oversize limit for most automobiles would be

a. 0.060"
b. 0.150"
c. 0.200"
d. 0.250"

_____3. Technician A says that the raised surface spots shown below can be removed by turning the drum on a lathe using a carbide tool bit.

Technician B says that these spots can be removed by grinding. However, they may reappear when heat is applied. The drum should really be replaced.

Who is right?



a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev.ed., © 1983, p. 9 (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____4. Drum brake fade could be caused by

a. Improper toe-heel clearance
b. Bell-mounted drums
c. Heavily glazed lining
d. All of the above

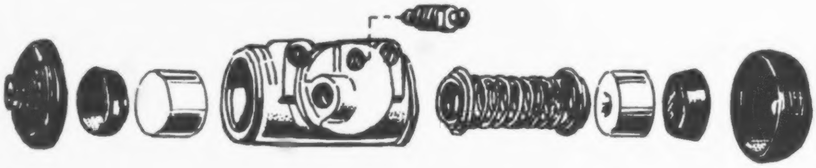
_____5. A honed wheel cylinder should be checked with a "No-Go" gauge, or inside micrometer, and should not exceed _______ over the original diameter.

a. 0.002"
b. 0.005"
c. 0.010"
d. 0.005"

_____6. The automobile pulls and there is light vibration when you apply the brakes hard. Which of the following could cause this condition.

a. Collapsing strut-rod insulations
b. Incorrect tire pressure
c. Leaky wheel cylinder
d. All of the above

_____7. The illustration below shows the layout of a wheel cylinder before assembly. Which item is not being installed properly?



a. Expander
b. Cup
c. Piston
d. Boot

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_____8. Which of the following drum brake designs is most widely used today?

a. Duo-servo fixed-anchor
b. Uni-servo fixed-anchor
c. Non-servo adjustable anchor
d. Self-energizing, self-centering dual-anchor

_____9. You have assembled a Bendix brake with a cable self-adjusting mechanism. You observe that the adjusting lever is below the center line of the star-wheel adjuster. A common cause for this is

a. The cable guide is not firmly seated against the secondary shoe
b. The cable guide is not firmly seated against the primary shoe
c. The cable is too short
d. Both a and c

_____10. On a combination brake system, which of the following would *most likely* cause a pulsating pedal?

a. Leaking wheel cylinder
b. Parking brake set while drums are hot
c. Blocked bypass port
d. Glazed linings

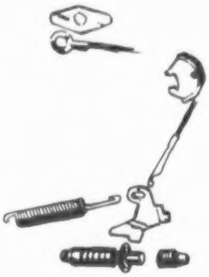
_____11. The rubber strap wrapped around the brake drum during turning on the lathe is used to

a. Cool the drum
b. Shield operator from flying chips
c. Prevent drum expansion
d. Reduce chatter

_____12. On a drum brake system, the master cylinder maintains residual pressure in order to

a. Keep wheel cylinder cups sealed against cylinder
b. Prevent air from entering system
c. Both a and b
d. Neither a nor b

______13. According to the illustration below, these parts are positioned for the



a. Front brakes only
b. Rear brakes only
c. Right side brakes
d. Left side brakes

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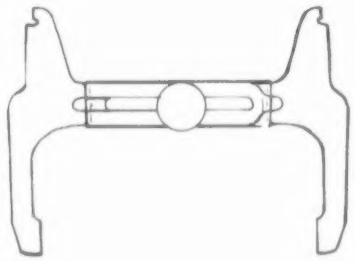
______14. Technician A says that the tool below gauges correct lining-to-drum clearance on automobiles using the Bendix-type fixed anchor self-adjusting brake.

Technician B says that the tool below gauges correct toe and heel clearance.

Who is right?



a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

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______15. When a brake drum has been turned 0.050" over OEM size, and the brake shoes are standard, which of the following would apply?

a. The shoes will contact the drum at the ends only
b. The shoes will fit the drum properly
c. The shoes will contact the drum at the center only
d. The shoes should be arc ground only at the ends

______16. When using a pressure bleeder for bleeding drum brakes, which of the following pressures would you use?

a. 2 to 8 psi
b. 15 to 30 psi
c. 40 to 65 psi
d. 60 to 80 psi

______17. On drum brakes, which of the following could cause a rising pedal on successive brake applications?

a. Insufficient pedal free travel
b. Master cylinder piston not returning to its stop
c. Both a and b
d. Neither a nor b

______18. Two technicians are discussing the lining used in duo-servo brakes. Technician A says that the secondary lining is usually longer than the primary lining. Technician B says that the primary lining is usually narrower than the secondary lining.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

______19. The platform or bosses on the backing plates support the

a. Brake shoes
b. Hold-down springs
c. Retracting springs
d. Star-wheel adjuster

_____20. Two technicians are discussing drum brakes. Technician A says that the anchor pins and blocks are usually permanently attached to the backing plates.

Technician B says that the rear backing plates are usually bolted to the rear axle housing.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

_____21. Which of the parts below keeps the brake shoes from turning with the drum when the brakes are applied?

a. Wheel cylinder
b. Hold-down assembly
c. Anchor pin or block
d. Star-wheel adjuster

_____22. In a self-energizing duo-servo brake, the primary shoe exerts a force on the secondary shoe through the

a. Wheel cylinder
b. Hold-down assembly
c. Retracting springs
d. Star-wheel adjuster

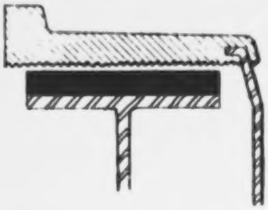
_____23. Technician A says that master cylinder used on a disc/drum combination system have a smaller reservoir for the front disc brakes than they do for the rear drum brakes.

Technician B says that the disc brake rotors in a combination system have a lower pressure requirements than the rear drums.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

______24. The drum illustrated below was turned at too fast a feed. This condition will cause



a. Low-speed squeal
b. A snapping noise as brakes are applied
c. Vibration
d. Fade

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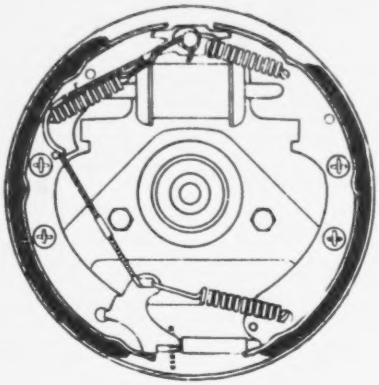
______25. Refer to the brake assembly illustrated below. In which direction must the drum turn in order to operate the self-adjusting mechanism?



a. Clockwise
b. Counterclockwise
c. Either direction
d. Not enough information given to answer the question correctly

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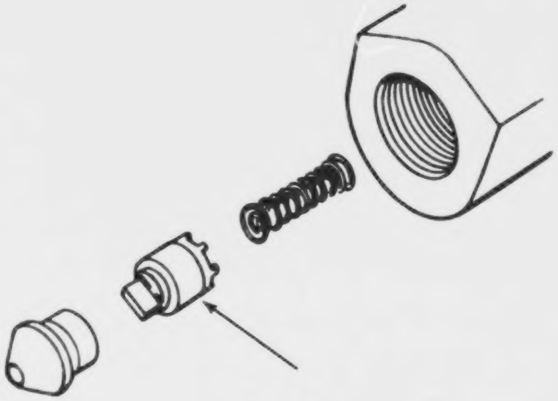
______26. Two technicians are discussing the hazards of breathing asbestos dust. Technician A says that breathing asbestos dust may cause asbestosis.

Technician B says that breathing asbestos dust may cause cancer.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

______27. The arrow in the illustration below is pointing to



a. A disc brake residual check valve
b. A disc brake bypass valve
c. A drum brake residual check valve
d. Both a and c

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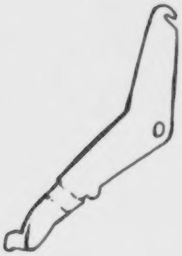
_____28. On a duo-servo brake with a lever-type self-adjuster, the part illustrated below is mounted on

I. The secondary brake shoe
II. The primary brake shoe



a. I only
b. II only
c. Either I or II
d. Neither I nor II

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_____29. In the past, brake lining were most commonly made of

a. Cast iron
b. Silicone
c. Asbestos
d. Rubber

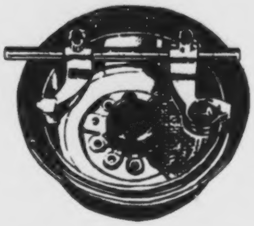
_____30. Larger brake shoes and drums are used on heavy automobiles because they

a. Absorb and transfer more heat
b. Must support the weight of the automobile
c. Have a lower coefficient of friction
d. Are subjected to higher hydraulic pressure

______31. Technician A says that the tool illustrated below checks drum out-of-roundness.

Technician B says that the tool below checks drum diameter.

Who is right?



a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev.ed., ©1983, p. 29 (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

______32. Which of the following should a brake specialist use to clean the wheel cylinder bore after honing?

a. Hot water and soap
b. Denatured alcohol
c. Cleaning solvent
d. Kerosene

______33. A vehicle is equipped with front and rear drum brakes. The driver complains of a clicking noise upon brake application.

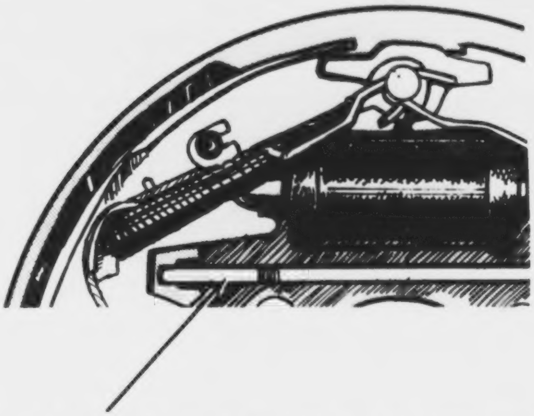
Technician A says that this could be caused by grooved backing plate ledges.

Technician B says that this could be caused by a loose anchor pin.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

_____34. The purpose of the brake part illustrated below it to



a. Center the shoes after each brake application
b. Equalize the force between the shoes during hard braking
c. Both a and b
d. Neither a nor b

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_____35. The rear brakes grab (lock-up) on a vehicle with hydraulic brakes. Which of the following could be the cause?

a. Grease on the linings
b. Out-of-round drums
c. Binding parking brake cable
d. All of the above

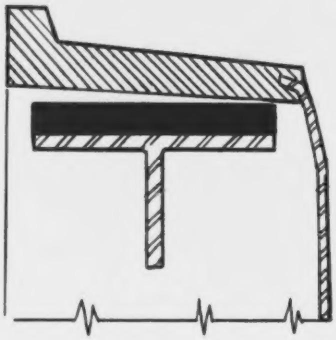
_____36. The temporary loss of braking caused by overheating is called

a. Sliding friction
b. Wet friction
c. Brake fade
d. Coefficient loss

_____37. The fit between a drum and lining is illustrated below. Technician A says that this drum is bell-mouthed.

Technician B says that this fit can cause brake fade.

Who is right?



a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev.ed., ©1983, p. 34 (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____38. After an automobile with drum brakes sits overnight, the pedal is low for the first stop in the morning. The rest of the day, the brakes are okay.

Technician A says that this could be caused by low brake fluid level.

Technician B says that this could be caused by a leaking residual valve.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

______39. A shop does a complete brake job on an automobile with drum brakes. One week later, the automobile returns with a low pedal.

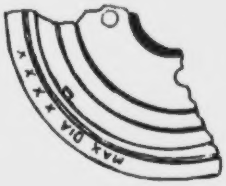
Technician A says that this could be cuased by installing the star-wheels on the wrong side.

Technician B says that this could be caused by glazed lining.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

______40. The marking on the brake drum illustrated below indicates



a. The maximum outside drum diameter
b. The grinding dimensions when replacing lining
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev.ed., © 1983, p. 39 (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

______41. Technician A says that weak retraction springs can cause rapid lining wear on drum brake.

Technician B says that weak hold-down springs can cause rapid lining wear on drum brakes.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

_____42. Technician A says that the anchor is located opposite the wheel cylinder on the backing plate of non-servo brakes.

Technician B says that on non-servo brakes during a stop while the car is moving forward, the reverse shoe is deenergized.

Who is right?

a. Technician A
b. Technician B
c. Both A and B
d. Neither A nor B

_____43. For a vehicle to have a high brake-pedal, its brake lining must be held close to the

a. Anchor pin
b. Brake drum
c. Backing plate
d. Wheel cylinder

_____44. On duo-servo brakes filled with cable-type or lever-type self-adjusters, the self-adjusting mechanism is usually mounted on the

a. Anchor pin
b. Cable guide
c. Adjuster lever
d. Star wheel

_____45. After refinishing a brake drum, you notice a herringbone pattern on the friction surface. The most probable cause of this problem is

a. The use of an improperly fitted radii adapter
b. An improperly sharpened tool bit
c. Cutting the drum at high feed speed
d. Improper drum vibration dampening

_____46. Brake spring pliers are usually used to remove and install

a. Hold-down springs
b. Wheel cylinder springs
c. Shoe retracting springs
d. Parking brake link springs

_____47. When replacing shoes in a non-servo brake fitted with a manually adjusted single star-wheel adjuster located under the wheel cylinder, the adjuster assembly should be installed

a. After the return springs are installed
b. After the hold-down assemblies are installed
c. After the shoe-to-anchor springs are installed
d. With the curved end of the adjuster screw facing upward

_____48. All of the following are types of wheel cylinders EXCEPT:

a. Double-piston double-bore
b. Double-piston straight bore
c. Double-piston step-bore
d. Single-piston

_____49. A component that is wallowed is

a. Turn or bent to one side
b. Having an enlarged or misshapen hole
c. Curved outward
d. Curved inward

_____50. Cable- and crank-type automatic adjusters are self-adjusting only when

a. The parking brake is applied
b. The vehicle is moving forward when brakes are applied
c. The vehicle is moving in reverse when brakes are applied
d. The vehicle is moving in forward or reverse when the brakes are applied

ACTIVITY ANSWERS

SERVICE DRUM BRAKES

ACTIVITY SHEET 1

1. Brake cylinder hone
2. Bleeder screw wrench
3. Wheel cylinder clamp
4. Enclosure-type brake cleaner
5. Hold-down spring tool
6. Brake spring pliers
7. Drum brake lathe
8. Drum brake adjusting spoon
9. Retracting spring (brake spring) tool
10. Brake drum micrometer
11. Drum-to-shoe gauge

ACTIVITY SHEET 2

1. b
2. a
3. b
4. d
5. b
6. d
7. c
8. a
9. a
10. b
11. d
12. c
13. d
14. a
15. c
16. b
17. c
18. c
19. a
20. b
21. c
22. d
23. d
24. b
25. b
26. c
27. c
28. a
29. c
30. a
31. c
32. b
33. c
34. d
35. d
36. c
37. c
38. b
39. a
40. d
41. c
42. a
43. b
44. a
45. d
46. c
47. a
48. a
49. b
50. c

JOB SHEET 1

SERVICE DRUM BRAKES

OBJECTIVE 8

Remove, clean, and visually inspect brake drums

INTRODUCTION

When a brake has been in use long enough for its lining to wear out, its drum usually has some defects, too. Because a cast iron brake drum wears at a much slower rate than the lining that contacts it, there may be the temptation to ignore the drum unless there is some obvious defect. But to yield to this temptation shows that the importance of the drum is not understood, and the result is an imperfect repair job.

If you know what to look for, you will find many common defects while inspecting brake drums. Brake drums must be removed from the vehicle before they can be inspected or refinished. Use the following procedure to remove, clean, and inspect brake drums.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Fender and seat covers
- Chisel
- Ball-peen hammer
- Diagonal cutting pliers
- Dust cap removing tool or channel-lock pliers
- Chalk or marker
- Lug wrench
- Sockets to fit lug bolts
- Rubber mallet
- Approved brake-cleaning solvent
- Shop towels
- Brake adjustment tool (brake spoon)
- Brake system inspection report form

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Cover fenders and seats

2. Raise vehicle and support safely

3. Remove wheel cover

4. On each rear wheel, mark lug hole and corresponding lug bolt

   NOTE: This is necessary in order to preserve tire balance upon reassembly.

5. Remove rear wheels and set aside

6. Mark each drum next to the marked lug, also indicating *left* and *right* to preserve balance during reassembly

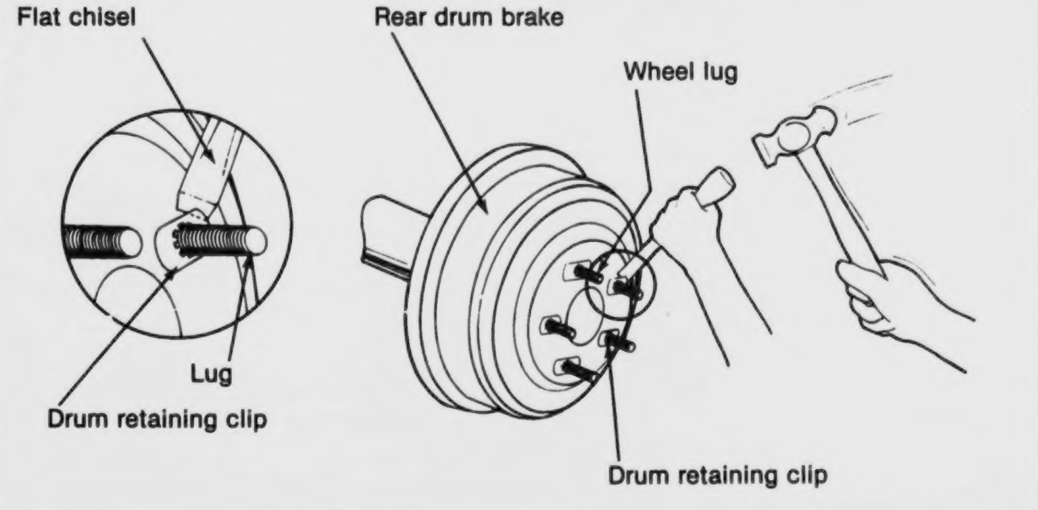
PROCEDURE

For removing brake drums from rear-wheel-drive vehicle

1. Make sure that parking brake is released

2. Use small, flat chisel and ball-peen hammer to loosen drum retaining clips as shown in Figure 1, taking care not to damage threads on wheel lugs when prying clip away from drum

FIGURE 1



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3. Grasp each clip with diagonal cutting pliers and pull away from drum and off lug; discard clips

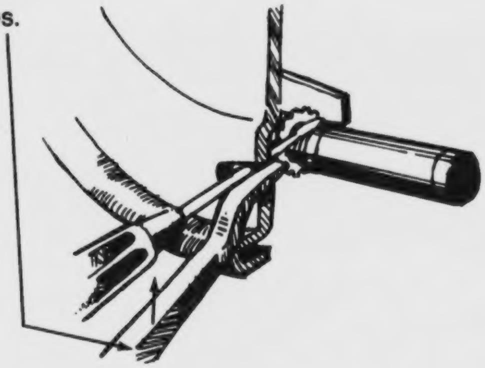
   NOTE: Drum retaining clips are usually found only on vehicles that have never had the drums removed. The clips do not need to be reinstalled or replaced.

4. Grasp drum with both hands and pull it out and away from axle

5. If drum moves out slightly but will not pull freely off axle, back off brake shoe adjustment as shown in Figure 2 and detailed in service manual

FIGURE 2

Move handle of brake adjusting tool upward to retract brake shoes.



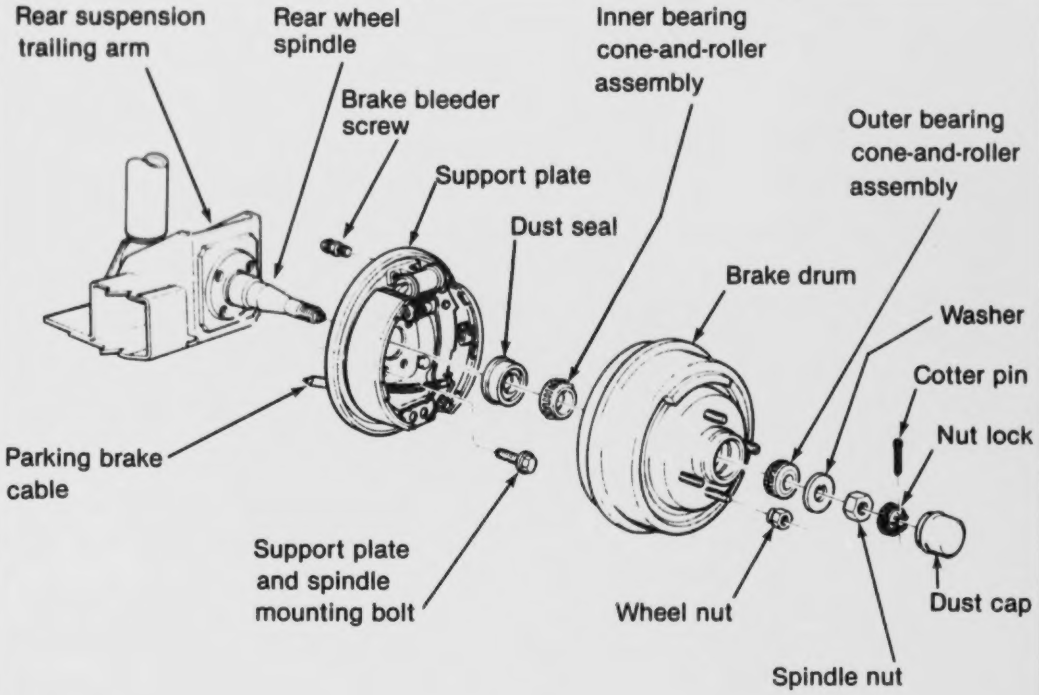
6. If rust has formed between drum and axle, causing drum to stick to axle flange, tap drum between lugs with hammer to break it loose

PROCEDURE

For removing brake drums from front-wheel-drive vehicles

NOTE: On vehicles with front-wheel-drive and rear drum brakes, the procedure for removing the rear drums may differ from that for removing rear-wheel-drive drums. Most front-wheel-drive vehicles have a rear drum setup similar to the one shown in Figure 3.

FIGURE 3


Rear suspension trailing arm
Rear wheel spindle
Inner bearing cone-and-roller assembly
Brake bleeder screw
Outer bearing cone-and-roller assembly
Support plate
Dust seal
Brake drum
Washer
Cotter pin
Nut lock
Parking brake cable
Support plate and spindle mounting bolt
Wheel nut
Dust cap
Spindle nut

Used with permission of Chrysler Corporation.

1. Using dust cap removing tool or channel-lock pliers, remove dust cap, taking care not to damage it
2. Using diagonal cutting pliers, straighten ends of cotter pin, pry it out of hole in spindle, and discard pin
3. Remove nut lock, spindle nut, and washer
4. Remove outer cone-and-roller assembly

5. Grasp brake drum with both hands, and pull it out and away from axle

6. *If* drum moves out slightly but will not pull freely off axle, back off brake shoe adjustment as shown in Figure 2

7. *If* rust causes drum to stick to axle flange, tap drum between wheel lugs with hammer to break it loose

PROCEDURE

For cleaning and inspecting brake drums

1. Clean disassembled brake assemblies and drums with approved brake-cleaning solvent following directions on solvent container

2. Visually inspect each drum for cracks, scoring, and hot spots

   NOTE: *If* drum is cracked, it must be replaced; *If* drum is scored, it must be refinished. Hot-spots cannot usually be removed by refinishing, and drums must be ground or replaced.

3. Continue to Job Sheet 2 to complete inspection

JOB SHEET 2

SERVICE DRUM BRAKES

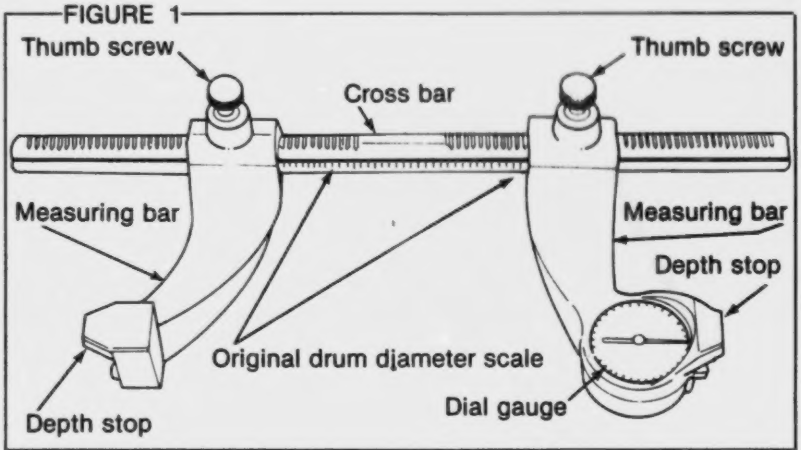
OBJECTIVE 9

Measure and refinish brake drums

INTRODUCTION

There are some drum defects that cannot be detected without the use of a brake drum micrometer, an instrument that measures the diameter of a brake drum in thousandths of an inch. There are many types of brake drum micrometers, but most are similar to the one shown in Figure 1.

FIGURE 1



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A drum brake lathe can be used to correct some brake drum defects by refinishing the brake drum. The lathe is also used to machine new brake drums to ensure that the new drums will be perfectly round when installed.

Other defects cannot be properly corrected by refinishing, and the drums can only be replaced. Visual inspection findings may indicate that brake drum replacement is necessary—cracked or broken drums must be replaced. Brake drums need to be replaced if they are oversized or if they will be oversized as a result of refinishing drums to correct defects or problems. Most manufacturers specify an acceptable maximum diameter of the brake drum after refinishing that is usually at least .030 inch less than the specification for maximum (discard) diameter (this allows for no more than .030 inch after refinishing for normal drum wear). Generally, if a drum is more than .060 inch over its original diameter, it cannot bear refinishing and must be discarded.

Another defect which cannot be corrected by using a lathe is hot spots. They can only be removed by grinding, and then they may reappear after grinding. It is usually recommended that a drum with hot spots be replaced.

Some defects which should be looked for and which may be corrected by refinishing (if brake drum diameter after refinishing does not exceed the manufacturer's specified maximum diameter) are listed below.

- Barrel shape
- Eccentric (off center)
- Bell mouth
- Taper
- Scoring
- Out-of-round (runout)

NOTE: If runout is excessive, the drum must be refinished; consult vehicle service manual for maximum runout specifications.

There are many different types of drum lathes in use, and the specific operating instructions vary with each design. For this reason, you should study the manual furnished with the lathe before attempting to refinish the brake drums. You must continue to wear eye protection at all times until final reassembly of brake assembly is complete.

EQUIPMENT AND MATERIALS

- Equipment and materials listed in Job Sheet 1
- Brake drum micrometer
- Drum brake lathe, appropriate adapters and accessories, and manual

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Remove, clean, and visually inspect brake drums (Job Sheet 1)

2. Measure drum with micrometer

   a. Find maximum diameter marking on drum, and set drum micrometer to this original diameter

      NOTE: American automobile manufacturers commonly use drums of even-inch or half-inch sizes. You will find drums that measure 9, 10, and 11 inches. You will also find some that measure 9 ½ inches, 10 ½ inches, and other half-inch sizes. If you are unable to find the diameter marking on the drum, consult the vehicle service manual.

   b. Insert micrometer into drum, and push it down until its depth stops hit edge of drum

      NOTE: *If* depth stops on micrometer are adjustable, position the micrometer so that it measures the widest distance across drum, such as when drum is bell-mouthed or tapered. *If* stops are not adjustable, be aware that measurement may not accurately reflect these conditions.

   c. With micrometer held in place, move one end back and forth in a slight arc until dial shows highest obtainable reading

   d. Find exact diameter of drum by adding this reading to diameter to which you set micrometer, and record findings

3. Repeat step 2 to measure other drum from same axle

4. Determine whether to refinish or replace each drum

   a. Replace if oversize or if the refinishing required to correct the defect will make the drum oversize

      CAUTION

      Any drum that is over the maximum diameter is unsafe and must be replaced rather than refinished.

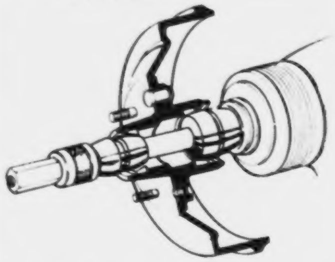
      NOTE: If drum does not meet specifications and must be replaced, most manufacturers recommend that a light machining cut be made on all new drums. This is because the cast iron drums can become distorted during storage. The cut ensures that the new drums will be perfectly round when you install them.

   b. Continue procedure to refinish if it appears that the problem can be corrected without making the drum oversize

5. Mount drum on lathe, following procedure outlined in lathe manual for type of drum you are working with

   NOTE: Three common types of brake drums, each mounted on a lathe, are illustrated in Figures 2 through 4 on the following page.

FIGURE 2



Hubbed drum with bearings and races

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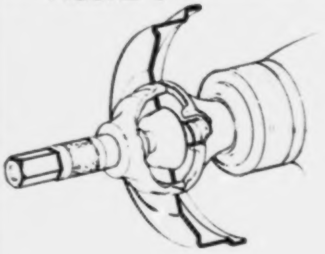
FIGURE 3



Front- or rear-wheel floating drum

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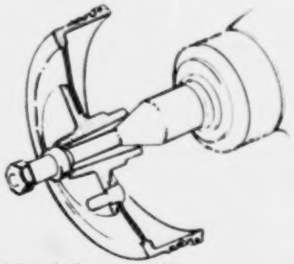
FIGURE 4



Hubbed drum with splined or tapered holes

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6. Check accuracy of mounting

   a. Turn cross slide handwheel inward (clockwise) to move tool bit away from surface of drum

   b. Turn feed handwheel so that tool bit is positioned inside drum about 1 inch from its outer edge

   c. Make sure that feed lever is in NEUTRAL, and turn on lathe

   d. While drum is rotating, slowly turn cross slide handwheel outward (counterclockwise) until tool bit barely touches surface of drum

   e. Turn off lathe

   f. Examine drum surface

      (1) *If* drum surface is perfectly round, the tool bit will have made a mark completely around drum; *if* this is the case, continue to step 7

      (2) *If* tool mark does not run completely around drum, drum is out-of-round, eccentric, or improperly mounted

         (a) Loosen arbor nut and rotate drum on arbor one-half turn

         (b) Tighten arbor nut and move feed handwheel slightly so that tool bit moves to one side of original mark

         (c) Turn on lathe so that tool bit makes a second mark

         (d) Turn off lathe and examine drum; *if* second mark is alongside the first, the drum is out-of-round or eccentric and your mounting is accurate; *if* the marks are not side by side, the drum was inaccurately mounted

         (e) *If* drum was inaccurately mounted, repeat steps (a) through (d) until you make a tool mark that is alongside the one made just before

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7. Install drum silencing band by stretching it around circumference of drum, making sure that it contacts all parts of outer surface of drum

   NOTE: The drum silencing band is used to dampen or silence vibrations that may be set up in the drum when it is being machined. If the drum vibrates when it is being refinished, the vibrations cause it to move in and out creating a rough surface called a herringbone pattern. A herringbone pattern on the finished surface of the drum causes rapid lining wear as it actually files away the lining. It will also cause brake pull and erratic braking.

8. Refinish drum

   a. Turn on lathe, and turn feed handwheel so that tool bit is drawn out toward edge of drum to cut into and remove "rust ridge" present at open edge of drum

   b. Turn feed handwheel back so that bit moves back into drum, continuing to turn wheel until bit starts to enter inner corner of drum

      CAUTION

      Proceed slowly here because there is usually another ridge in the corner.

   c. Continue turning handwheel slowly until bit cuts away inner ridge and reaches inner edge of drum surface

   d. Note setting on dial of cross slide handwheel; advance it .005 inch to push bit into drum surface

   e. Lock cross slide so that your adjustment will not change

   f. *If* lathe has a feed speed dial, adjust it to 16 to provide a relatively fast cut; *If* lathe has two speeds, shift feed into fast-cut or rough-cut position

   g. Lock your adjustment and engage the feed lever

   h. When cut is finished and tool bit is clear of drum, disengage feed lever and turn off lathe

   i. Inspect drum surface; *if* defects still exist, start lathe and turn feed handwheel to run lathe back into corner; *if* defects are corrected, continue to step *m*

j. Loosen lock on cross slide and advance handwheel another .005 inch

k. Engage feed lever for another fast cut

l. Repeat fast cuts of .005 inch until all defects are eliminated

m. Run tool bit back into corner of drum and advance cross feed handwheel .002 inch

n. *If* lathe has a feed speed dial, adjust it to 2; *if* lathe has two speeds, shift feed lever into slow-cut or fine-cut position

o. Lock your adjustment and engage feed lever

p. When cut is finished and tool bit is clear of drum, disengage feed lever and shut off lathe

q. Visually inspect drum surface; surface should be smooth to the eye and touch

r. Remove drum from arbor, and remove silencing band from drum

9. Measure drum with micrometer to make sure that its diameter does not exceed greatest allowable oversize after machining

   NOTE: This is usually .060 inch.

10. Repeat steps 5 through 9 to mount and refinish second drum, machining it to within .015 inch of first

11. Clean newly refinished drums

   NOTE: The friction surface of a newly refinished drum contains millions of tiny metal particles. These particles not only remain free on the drum surface, but lodge themselves in the open pores of the surface. If these metal particles are allowed to remain in the drum, they become embedded in the brake lining. Once the brake lining is contaminated in this way, it acts as a fine grinding stone and scores the drum.

   ► WARNING ◄

   Do not attempt to clean the drum of metal particles by blowing out the drum with air pressure. The tiny metal particles in the drum can be harmful to your health.

a. Remove wheel bearings and grease seals from hub, if applicable

CAUTION

If front hubs and drums are being cleaned, be very careful to avoid contamination of wheel bearing grease. Or, completely remove all old grease, then regrease and repack wheel bearings after drum has been washed and dried.

b. Wash brake drum thoroughly with hot water, wipe with lint-free rag, and thoroughly dry with air pressure; or, wipe inside of brake drum with lint-free rag dipped in approved brake-cleaning solvent and allow to dry before reinstallation

12. Clean work area and return equipment and materials to proper storage, or continue to Job Sheet 3 as directed by your instructor

JOB SHEET 3

SERVICE DRUM BRAKES

OBJECTIVE 11

Remove, clean, and inspect brake shoes and related hardware

INTRODUCTION

Each time the brakes on a moving vehicle are applied, a slight amount of brake lining is worn away. Depending on the type of use to which the vehicle is subjected and the skills of the driver, brake lining life will average 20,000 miles to 40,000 miles. The inspection of the brake lining is an important part of routine maintenance. A worn lining can decrease the effectiveness of braking and may cause an accident. Not only is a worn lining dangerous, it can cause excessive drum wear, requiring replacement of these parts.

Because of the variety of drum brake mechanisms and hardware, the brakes specialist must refer to the appropriate service manual when removing brake shoes, linings, and related hardware. Some guidelines, however, are general to the procedure, and those are listed below.

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

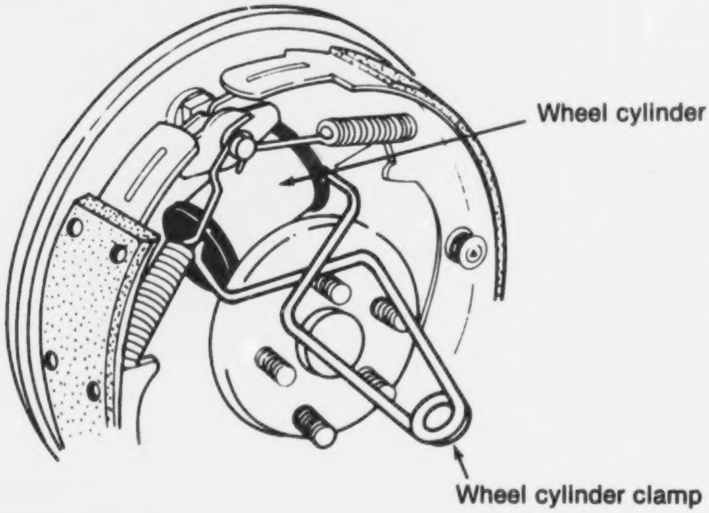
  ► WARNING ◄

  Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

- Do not disassemble both drum brake assemblies at the same time. Perform all of the procedures to remove, clean, and replace the brake shoes on one side of the vehicle before you disassemble the other side. Working this way ensures that you will reassemble the brakes properly, since you can always refer to the position of the parts on the assembled side.

- If you will not be rebuilding or replacing the wheel cylinder as part of brake shoe replacement procedure, install a wheel cylinder clamp as shown in Figure 1 on the following page to prevent the pressure that remains in the hydraulic system from pushing the wheel cylinder pistons and cups too far out in the bore when you remove the brake shoe retracting springs.

FIGURE 1



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- As you remove the brake hardware, place the parts on the workbench in the same positions they were on the backing plate. Also note the color, shape, and size of the various parts. This procedure will help you differentiate parts that look almost alike, such as the secondary and primary retracting springs and the automatic adjusting spring.

- Since the removed shoes and their linings will be exchanged with reconditioned shoes and new linings, do not attempt to clean the removed shoes.

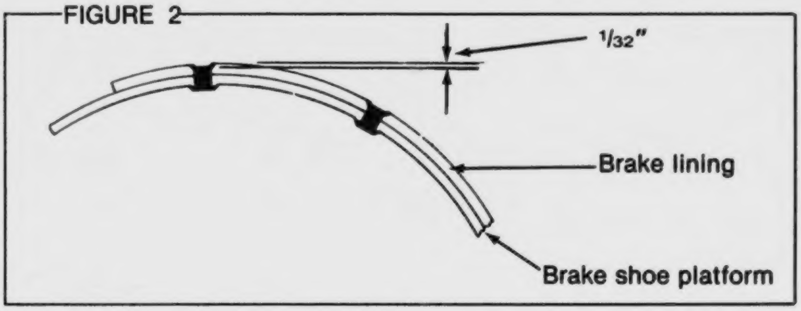
- If any shoe retracting spring needs to be replaced, you must replace *both* primary and secondary shoe retracting springs on both wheels of the axle to ensure equal braking action.

- Unless you plan to rebuild or replace the wheel cylinder, leave the pushrods in position in the center of the wheel cylinder dust boots. Keeping the pushrods in place will prevent contaminants from entering the wheel cylinder when you clean the backing plate.

- When cleaning the backing plate, take care not to get excess solvent around the dust boots of the wheel cylinder as it could contaminate the brake fluid and damage the rubber parts.

- Contaminated linings must be replaced, and the cause of the contamination should be located and repaired. If linings at one wheel require replacement, the linings of the other wheel of the same axle must also be replaced to obtain equal braking.
- Inspect linings for wear, using specifications in service manual and illustrations below for guidelines.
- Replace riveted lining (Figure 2) if it is worn to less than 1/32 inch over heads of rivets.

FIGURE 2



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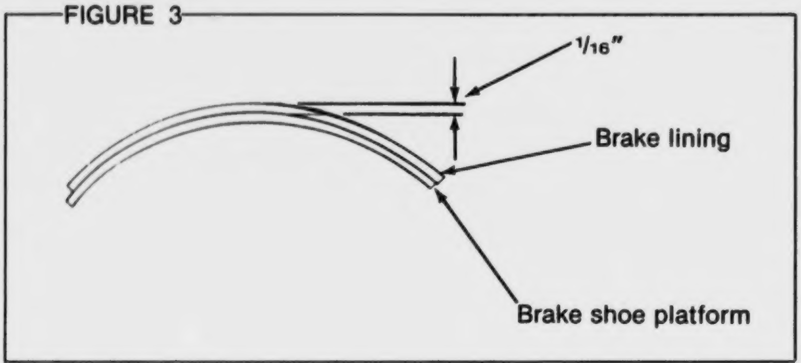
- Replace bonded lining (Figure 3) if it is worn to less than 1/16 inch in thickness

FIGURE 3



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EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

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JOB SHEET 4

SERVICE DRUM BRAKES

OBJECTIVE 14

Remove, recondition, and reinstall a wheel cylinder

INTRODUCTION

When inspecting a wheel cylinder, an inexperienced person may flip back the lower end of each boot and, if there is no appearance of fluid, assume that the cylinder does not need to be serviced. However, as the brake linings wear, the pistons and cups move farther outward within the bore. As they move outward, contamination is introduced into the bore. When the new shoes are installed, the system will remain contaminated unless the cylinder is reconditioned or replaced. Contaminants will cause quicker wear of the wheel cylinder assembly, which may result in internal leakage.

Reconditioning the wheel cylinder may include refinishing the cylinder bore walls if they are scratched or scored. However, there are limitations on honing the cylinder bore. For example, the cylinder bore should not be increased by more than .002 inch, and aluminum wheel cylinders cannot be honed and must be replaced.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Fender and seat covers
- Lug wrench
- Sockets to fit lug bolts
- Brake bleeding equipment
- Box wrench or brake bleeder wrench
- Feeler gauge
- Brake cylinder hone
- Electric drill motor
- Open-end wrench set
- Channel-lock pliers
- Diagonal cutting pliers
- Crocus cloth
- Lint-free shop cloths
- Tubing wrenches
- Torque wrench
- Clean, approved brake fluid
- Recommended lubricant
- Denatured alcohol
- Shop towels
- Line plugs or caps

- Rubber mallet
- Replacement parts as necessary
- Penetrating oil

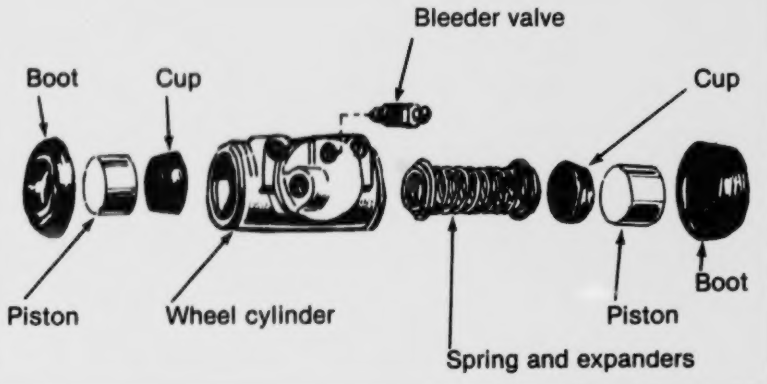
► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Cover fenders and seats
2. Raise vehicle and support safely
3. Remove tire-and-wheel assembly and brake drum assembly (Job Sheet 1)
4. Remove brake shoes (Job Sheet 3)
5. Disconnect brake line from wheel cylinder, taking care to prevent twisting line
6. Plug or cap ends of line to prevent contamination
7. Inspect brake lines; *if* lines are defective, discard and replace with new during reinstallation
8. Remove wheel cylinder attaching bolts
9. Remove wheel cylinder from backing plate
10. Disassemble wheel cylinder using Figure 1 below for reference

FIGURE 1



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   a. Remove bleeder valve screw from cylinder with six-point socket or brake bleeder wrench

      NOTE: *If* bleeder valve is seized in the cylinder, the cylinder must be replaced; if a cylinder's bleeder screw cannot easily be removed, the system cannot be bled.

   b. Remove wheel cylinder actuating pins

   c. Remove wheel cylinder boots

   d. Push out pistons, cups, spring, and expanders

11. Clean and inspect wheel cylinder components

   a. Clean all reusable metal parts with clean, approved brake fluid

      NOTE: Rubber parts such as cups and boots are not reusable and should be replaced with new ones.

   b. Inspect pistons for scratches, scoring, or corrosion; *If* pistons are pitted or show signs of wear, replace

   c. Inspect bleeder valve for defective threads or dirt; *If* threads are defective, replace valve with new valve; *If* dirty, clean with brake fluid

   d. Inspect wheel cylinder bore for scratches, scoring, and discoloration

12. *If* cylinder bore is discolored or stained, polish with crocus cloth

   NOTE: This is best accomplished by covering your finger with crocus cloth, then inserting into cylinder and twisting finger.

13. *If* cylinder bore walls are scratched or scored, clamp in vise and recondition with cylinder hone

   CAUTION

   The cylinder bore should not be increased by more than .002 inch. A cylinder that requires honing beyond .002 inch should be replaced. See manufacturer's recommendations.

   a. Secure cylinder in vise by clamping supporting bracket of cylinder in vise or by wrapping cylinder with cloth and clamping cylinder in vise (See Figure 2)

      NOTE: Tighten vise only enough to secure cylinder. Overtightening may result in damage, such as abrasions, to cylinder body.

b. Pass a lint-free cloth through bore several times to remove any loose contamination

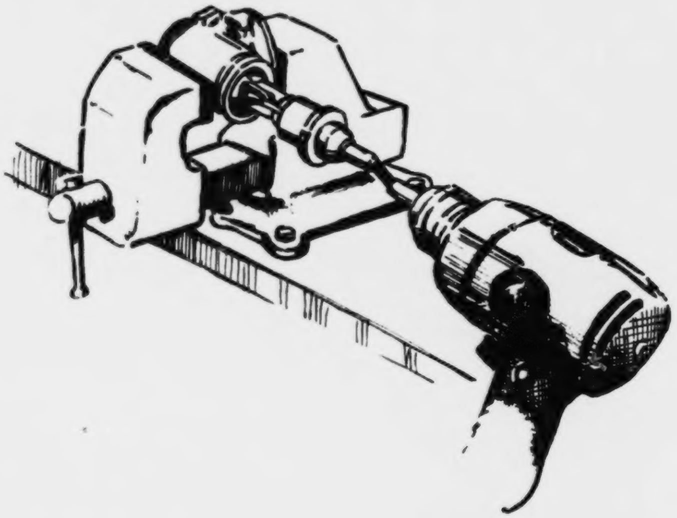
c. Dip hone stones in clean brake fluid and attach to drill motor

d. Insert hone in cylinder bore, and turn on drill motor; rotate and polish bore (Figure 2)

CAUTION

Take care **not** to allow the stones of the hone to slip out of the bore during this step as damage to the stones would result.

FIGURE 2



e. Wash inside of bore with denatured alcohol and dry with compressed air

f. Using a suitable light, inspect interior of bore for signs of dark areas, indicating a depression in the surface; *If* bore is not polished along full length of travel of pistons and cups, replace wheel cylinder with new one

g. Determine if bore's diameter is oversize

   (1) Install pistons in cylinder bore

(2) Measure cylinder bore diameter and select appropriate feeler gauge (Table 1)

TABLE 1

If cylinder bore diameter is—	Feeler gauge thickness should be—
3/4 inch to 13/16 inch	.006 inch
1 1/4 to 1 7/16 inch	.007 inch
1 1/2 inch	.008 inch

(3) Attempt to insert feeler gauge; *if* gauge enters bore, wheel cylinder is **not** usable and must be replaced

(4) Remove pistons

14. Blow out passage for bleeder valve with compressed air

15. Coat threads of bleeder valve with recommended lubricant

16. Install and tighten valve

17. Reassemble wheel cylinder

    a. Coat cups, pistons, and cylinder bore with clean brake fluid

    b. Install expanders on spring as required

    c. Install spring and expanders into wheel cylinder, taking care **not** to scratch cylinder bore

    d. Install new cups positioned with lips toward center of cylinder, taking care **not** to damage cup lips during installation

    e. Install pistons, positioned with flat ends toward center of cylinder

    f. Install new boots, making sure that boot lips are seated in grooves at ends of cylinder

    g. Install cylinder links if applicable

18. Reinstall wheel cylinder on backing plate, torquing bolts or anchor pin to manufacturer's specifications

19. Remove plugs or caps from brake line, and reinstall brake line on wheel cylinder, taking care to avoid cross-threading

20. Reinstall brake shoes and drums, following procedure in service manual

21. Manually bleed brake system at required wheel cylinder

22. Check master cylinder fluid level, and refill with clean, approved brake fluid to at least three-quarters full if necessary

CAUTION

Take care **not** to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do **not** allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

23. Reinstall tire-and-wheel assembly, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub

24. Lower vehicle to floor

25. Torque lug nuts to manufacturer's specifications

26. Install wheel covers, tapping in place with rubber mallet

27. Road test vehicle

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

28. Clean work area and return equipment and materials to proper storage

JOB SHEET 5

SERVICE DRUM BRAKES

OBJECTIVE 16

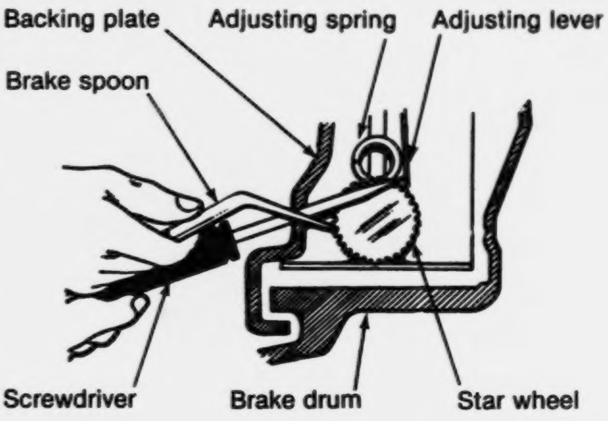
Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies

INTRODUCTION

Modern brake designs incorporate the drum brake self-adjusting mechanism. Brakes that feature this self-adjusting mechanism may never require a minor adjustment; the brake is designed to adjust itself. However, the self-adjusting mechanism may fail, requiring a check and adjustment of the mechanism as well as a manual adjustment of the lining-to-drum clearance. The brakes specialist must be able to make these types of adjustments.

Manual Brake Shoe Adjusters

Modern drum brakes are designed with devices that adjust the position of the brake shoes to the drum. This adjustment is necessary because the shoes wear during use. To make up for this wear, the adjusters slowly push the shoes outward as they wear. This maintains throughout the life of the shoes approximately the same distance between the shoes and the drums when the brakes are not applied. Although automatic adjusters work in various ways, most are activated when the brakes are applied while the vehicle is backing. But it is also sometimes necessary to be able to adjust brake shoes manually. This may be required to free the drum so that it can be removed or to position newly installed drums or as a result of other service. The illustration below shows one method of manually adjusting brake shoes. One tool is used to hold down a release mechanism while another is used to turn the star wheel, which moves the shoes. Although the design of the automatic adjusting mechanism varies greatly from one vehicle to another, the manual adjustment procedure in the illustration is typical of many vehicles. Service manuals explain how to adjust brakes manually on specific vehicles and may provide detailed adjustment guidelines for particular procedures.



From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

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The following procedure is applicable for most vehicles that have drum brakes with star-wheel adjusters. However, some vehicles with star-wheel adjusters will use slightly different procedures, and other vehicles without star-wheel adjusters will use a completely different procedure. Refer to manufacturer's service manual for exceptions.

EQUIPMENT AND MATERIALS

- Equipment and materials listed in Job Sheets 1 and 3
- Drum-to-shoe gauge

PROCEDURE

1. Remove, clean, and inspect brake drums and shoes (Job Sheets 1 and 3)

2. Reassemble brake assembly, following instructions in service manual

3. Inspect self-adjusting mechanism

   a. Check mechanism for broken or improperly installed parts

   b. Hold adjusting lever out of engagement with star-wheel adjusting screw

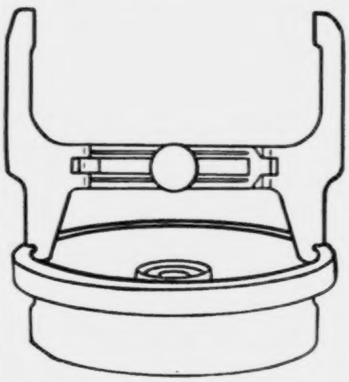
   c. Rotate star-wheel adjusting screw to make sure that it is free turning

4. Adjust lining-to-drum clearance

   NOTE: You may have to loosen the parking brake adjustment in order to complete the lining-to-drum adjustment.

   a. Insert gauge into drum, and adjust inside caliper part of gauge to drum diameter (Figure 1)

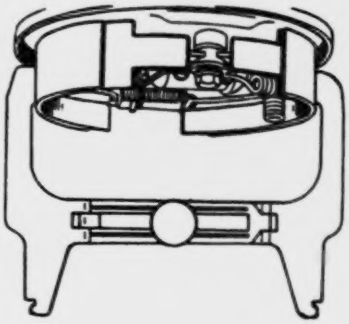
FIGURE 1



b. Lock the gauge

c. Remove gauge from drum, and place outside caliper part of gauge across centers of shoes (Figure 2)

FIGURE 2



d. Expand star wheel by hand until shoes just touch gauge

NOTE: The drum-to-shoe gauge is designed to provide a lining-to-drum clearance of .010 inch.

e. Rotate gauge around shoes to check setting

5. Install each drum in its original position on vehicle, making sure to align each marked lug and lug hole
6. Bleed brake system
7. Check parking brake adjustment and adjust as necessary (Refer to Job Sheet 6)
8. Install rear tire-and-wheel assemblies, making sure that they are in their original positions and tightening lug nuts in a cross pattern just enough so that wheel is snug against hub
9. Lower vehicle to floor
10. Torque lug nuts to manufacturer's specifications
11. Install wheel covers, tapping in place with rubber mallet

12. Road test vehicle

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

13. Clean work area and return equipment and materials to proper storage

JOB SHEET 6

SERVICE DRUM BRAKES

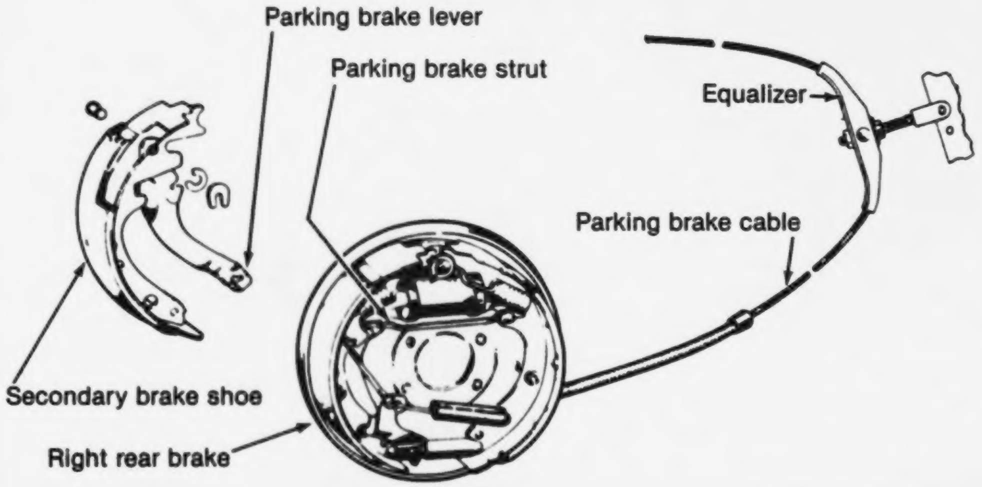
OBJECTIVE 17

Adjust an integral parking brake

INTRODUCTION

Figure 1 below shows the components of a typical integral parking brake removed from the wheel brake for easy identification.

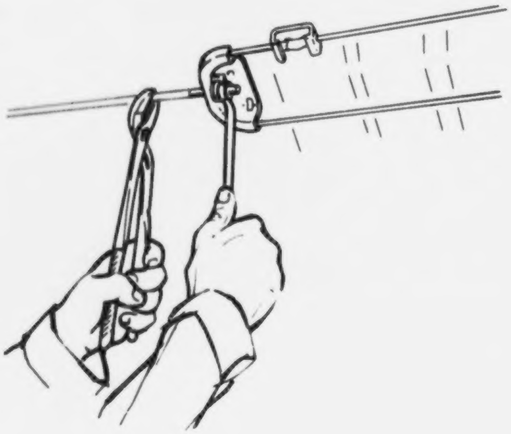
FIGURE 1


Parking brake lever
Parking brake strut
Equalizer
Parking brake cable
Secondary brake shoe
Right rear brake

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

Although specific cable adjustments depend on the vehicle model, only simple tightening adjustments are needed to take up the slack caused by cable stretch and/or shoe wear (Figure 2). Adjustment is done at the equalizer. If the front cable must be adjusted, do this first. Then engage the operating lever at least one notch before adjusting rear cables. This helps avoid overtightening, which would expand the brake shoes into contact with the drum and cause rear wheel drag.

FIGURE 2



Used with permission of General Motors Corporation, Delco Moraine Division.

Remember the following guidelines when adjusting an integral parking brake.

- It may be necessary to hold the front cable to prevent it from turning.
- After making adjustment, make sure that both check nuts (if two are used) are tight against equalizer.
- After adjustment, always apply and release parking brake several times to test operation.
- With parking brake released, make sure that there is no drag on the rear wheels.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 1

Remove, clean, and visually inspect brake drums

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed brake drums from rear-wheel-drive vehicle following outlined procedure.	______	______
4. Removed brake drums from front-wheel-drive vehicle following outlined procedure.	______	______
5. Cleaned and inspected brakes following outlined procedure.	______	______
6. Completed service correctly.	______	______
7. Observed safety rules and precautions.	______	______
8. Correctly filled out brake system inspection report form.	______	______
9. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 2

Measure and refinish brake drums

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Removed, cleaned, and inspected brake drums following outlined procedure.	______	______
3. Measured brake drums with micrometer following outlined procedure.	______	______
4. Correctly determined whether to refinish or replace each drum.	______	______
5. Mounted drum on lathe following procedure outlined in lathe manufacturer's manual.	______	______
6. Checked accuracy of mounting following outlined procedure.	______	______
7. Installed drum silencing band.	______	______
8. Properly set up lathe for turning.	______	______
9. Refinished drum following outlined procedure.	______	______
10. Measured drum after refinishing.	______	______
11. Cleaned drum after refinishing following outlined procedure.	______	______
12. Completed service correctly.	______	______
13. Observed safety rules and precautions.	______	______
14. Correctly filled out brake system inspection report form.	______	______
15. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 3

Remove, clean, and inspect brake shoes and related hardware

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Disassembled drum brake assemblies correctly, working on one side of the vehicle at a time and placing hardware on workbench in same positions they were on the backing plate.	______	______
4. Installed wheel cylinder clamp if wheel cylinder was not to be rebuilt or replaced.	______	______
5. Inspected shoes, linings, and related hardware following procedure outlined in vehicle manufacturer's service manual.	______	______
6. Inspected linings for wear according to procedure and specifications in vehicle manufacturer's service manual.	______	______
7. Correctly determined if any parts needed to be replaced.	______	______
8. Cleaned appropriate parts following procedure outlined in vehicle manufacturer's service manual.	______	______
9. Completed service correctly.	______	______
10. Observed safety rules and precautions.	______	______
11. Correctly filled out brake system inspection report form.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 4

Remove, recondition, and reinstall a wheel cylinder

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Correctly disconnected brake line from wheel cylinder and plugged or capped line ends.	______	______
4. Removed wheel cylinder following outlined procedure.	______	______
5. Disassembled wheel cylinder following outlined procedure.	______	______
6. Cleaned and inspected wheel cylinder components following outlined procedure.	______	______
7. Correctly determined if any parts needed to be replaced.	______	______
8. Reconditioned cylinder bore following outlined procedure.	______	______
9. Correctly determined if bore's diameter was oversized.	______	______
10. Serviced and installed bleeder valve following outlined procedure.	______	______
11. Reassembled wheel cylinder following outlined procedure.	______	______
12. Reinstalled wheel cylinder on backing plate, and reinstalled brake line on wheel cylinder.	______	______
13. Bled brake system.	______	______
14. Completed service correctly.	______	______
15. Observed safety rules and precautions.	______	______
16. Correctly filled out brake system inspection report form.	______	______
17. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 5

Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Removed, cleaned, and inspected brake drums and shoes.	______	______
3. Reassembled brake assembly following instructions in service manual.	______	______
4. Inspected self-adjusting mechanism following outlined procedure.	______	______
5. Adjusted lining-to-drum clearance following outlined procedure.	______	______
6. Properly installed drums.	______	______
7. Bled brake system.	______	______
8. Completed service correctly.	______	______
9. Observed safety rules and precautions.	______	______
10. Correctly filled out brake system inspection report form.	______	______
11. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DRUM BRAKES

JOB SHEET 6

Adjust an integral parking brake

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Adjusted integral parking brake following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Completed service correctly.	______	______
5. Observed safety rules and precautions.	______	______
6. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

WRITTEN TEST

SERVICE DRUM BRAKES

Name ______________________ Score ____________

OBJECTIVE 1

Choose the definitions that best define the following terms associated with drum brakes. Write the correct numbers in the blanks.

______a. **Drum brake**

1. Brake design in which a friction block contacts outer circumference of wheel to produce braking action
2. Brake design in which an external band of flexible steel lined with friction material wraps around drum or hub and is tightened by application of brake pedal
3. Brake design in which curved brake shoes press against inner circumference of a rotating metal drum to produce braking action

______b. **Dissipate**

1. To disintegrate or make disappear
2. To integrate or dissolve
3. To break up and scatter; to dispense or make disappear

______c. **Eccentric**

1. Disc or lobe (cam) used to convert rotary action to reciprocating action; off-center
2. Disc or lobe (cam) used to convert static to kinetic energy; egg-shaped
3. Disc or lobe (cam) used to convert rotary to linear action; wallowed

______d. **Flange**

1. Arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary
2. Projecting lip, rim, or edge
3. Device that prevents leakage at wheel cylinders

_____e. **Honing**

1. Removing metal with fine abrasive stone
2. Sharpening metal with a fine abrasive stone
3. Scoring metal with a fine abrasive stone

_____f. **Labyrinth seal**

1. Seal formed by wheel hub and drum rim that prevents water splashed from road to enter brake mechanism
2. Seal formed by wheel cylinder piston and cylinder boot that prevents water splashed from road to enter brake mechanism
3. Seal formed by backing plate flange and drum rim that prevents water splashed from road to enter brake mechanism

_____g. **Pawl**

1. Projecting lip, rim, or edge
2. Brake valve that prevents leakage at wheel cylinders
3. Arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary

_____h. **Primary shoe**

1. In non-servo brakes, that shoe toward front of forward-moving vehicle
2. In servo brakes, that shoe toward front of forward-moving vehicle
3. In servo brakes, that shoe toward rear of forward-moving vehicle

_____i. **Recondition**

1. To machine or return a part to its original surface condition
2. To disassemble, clean, replace defective parts, and reassemble a component or assembly
3. To replace a component or assembly with one of the original diameter or state

______j. **Residual valve**

1. Device that reduces pressure to rear wheels during braking
2. Device that maintains pressure in the system after brake pedal is released to prevent leakage at wheel cylinders
3. Device that allows air or liquid to pass in one direction only

______k. **Secondary shoe**

1. In non-servo brakes, that shoe toward front of forward-moving vehicle
2. In servo brakes, that shoe toward rear of forward-moving vehicle
3. In non-servo brakes, that shoe toward rear of forward-moving vehicle

______l. **Self-adjusting**

1. Process of compensating for shoe wear by automatically adjusting lining thickness
2. Process of compensating for shoe wear by automatically adjusting shoe-to-lining clearance
3. Process of compensating for shoe wear by automatically adjusting shoe-to-drum clearance

______m. **Self-energizing**

1. Use of friction to force brake shoes tighter against linings
2. Use of primary shoe to help apply secondary shoe
3. Use of friction to force one brake shoe tighter against drum

______n. **Servo action**

1. Process that results when both shoes are free to swing into drum, and primary shoe helps apply secondary shoe
2. Process that results when one side is energized and other shoe is de-energized
3. Process that results when both shoes are free to swing into drum, and secondary shoe helps apply self-adjusting mechanism

OBJECTIVE 2

Write the correct uses for each of the following drum brake service specialty tools.

a. **Drum brake adjusting spoon** —

b. **Brake spring pliers** —

c. **Hold-down spring tool** —

d. **Drum brake lathe** —

e. **Enclosure-type brake cleaner** —

f. **Drum-to-shoe gauge** —

g. **Retracting spring (brake spring) tool** —

h. **Wheel cylinder clamp** —

i. **Brake cylinder hone** — ______________________________

____

____

j. **Bleeder screw wrench** — ______________________________

____

____

k. **Drum brake micrometer** — ______________________________

____

____

OBJECTIVE 3

List below the basic steps of drum brake operation.

1. ____

____

____

2. ____

____

____

3. ____

____

____

4. ____

____

____

5. ____

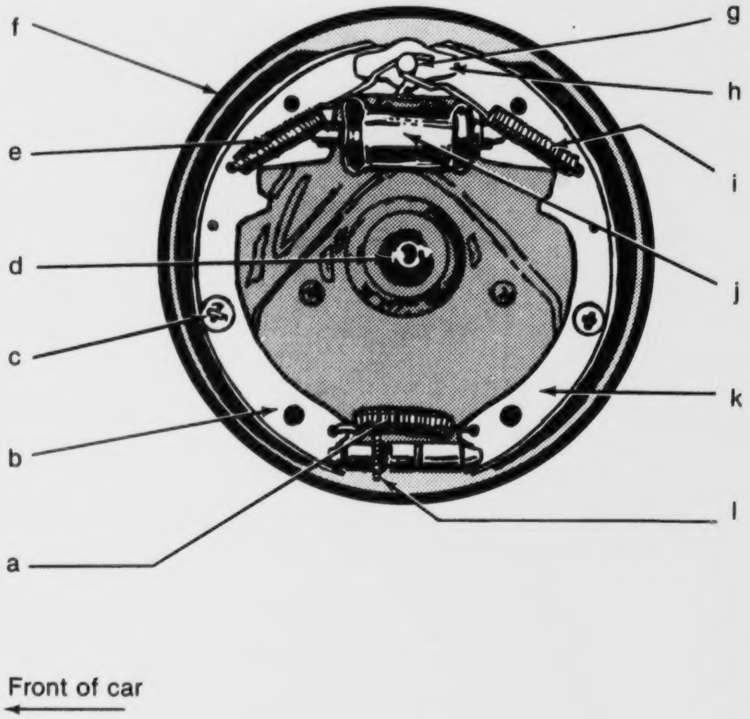
____

____

OBJECTIVE 4

Label the components of the following typical duo-servo and non-servo brake assemblies.

Duo-servo assembly



Adapted with permission of Raybestos/Brake Systems, Inc.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

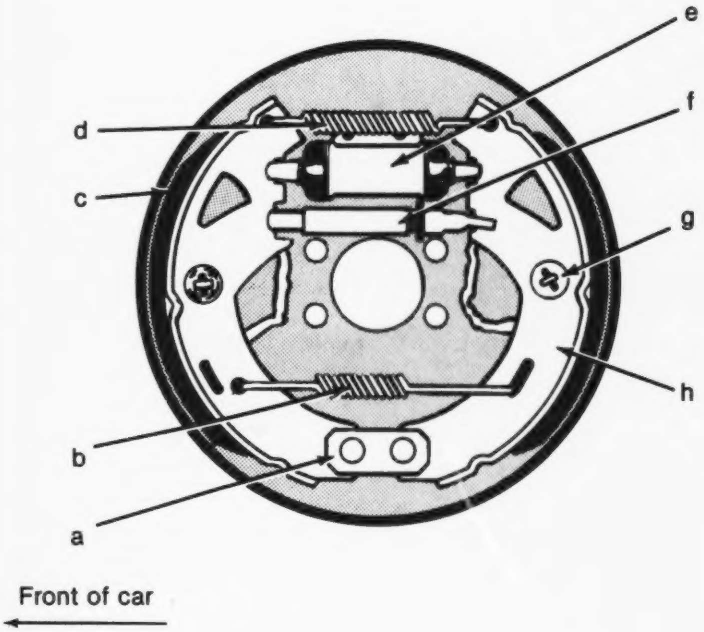
i. ______________________________

j. ______________________________

k. ______________________________

l. ______________________________

Non-servo assembly


e
f
d
c
g
h
b
a
Front of car

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

OBJECTIVE 5

Match the components of a duo-servo brake assembly to their correct functions. Write the correct numbers in the blanks.

______a. Provides mounting surface for lining

______b. Holds all of the brake parts except the drum

______c. Pushes shoes farther apart as lining wears

______d. Pulls shoes away from drum when brakes are released

______e. Holds shoes flat against backing plate

______f. Pushes brake shoes out into contact with drum

______g. Prevents shoes from turning with the brake drum

______h. Contacts drum and provides friction necessary for braking action

______i. Holds shoes together at star-wheel adjuster

1. Backing plate
2. Anchor pin
3. Hold-down assembly
4. Retaining spring
5. Star-wheel adjuster
6. Wheel cylinder
7. Retracting spring
8. Brake shoe
9. Brake lining

OBJECTIVE 6

Match terms associated with brake drum problems to their correct definitions. Write the correct numbers in the blanks.

_____a. Having enlarged or misshapen hole due to wear or rubbing

_____b. Condition of no longer being perfectly round or true

_____c. Curved outward

_____d. Curved inward

_____e. Twisted out of shape or changed from usual or normal shape

_____f. Forcing material out of its regular shape or condition by high-pressure rubbing

_____g. Having a common center

_____h. Severe overheating of an object resulting in a change of the material content

_____i. Having shiny, glass-hard resin deposits on surface

_____j. Loss of braking friction caused by excessive heat

_____k. Turned or bent to one side

_____l. Not having a common center; out-of-round

1. Carbonizing
2. Concave
3. Convex
4. Concentric
5. Deflection
6. Distorted
7. Eccentric
8. Fade
9. Galling
10. Glazed
11. Wallowed
12. Warpage

OBJECTIVE 7

List defects to look for when visually inspecting drum brake components. You must list at least 3 defects for each component.

a. **Brake lining**

____

____

____

____

b. **Drum**

c. **Backing plates**

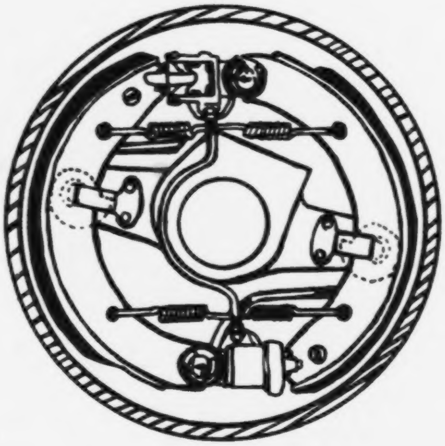
d. **Shoe retainer and spring nail assemblies**

e. **Retaining springs**

f. **Automatic adjuster assemblies**

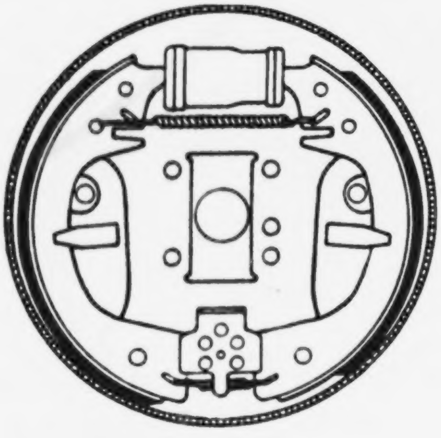
OBJECTIVE 10

Write the correct names for the following illustrations of common types of brake shoe mountings.



Used with permission of Raybestos/Brake Systems, Inc.

a. ______________________________

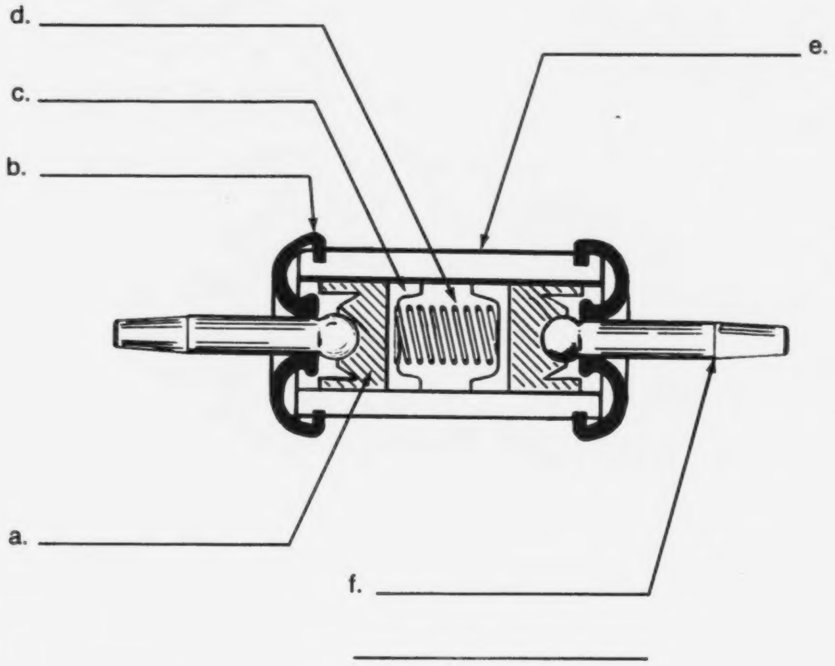


Used with permission of Raybestos/Brake Systems, Inc.

b. ______________________________

OBJECTIVE 12

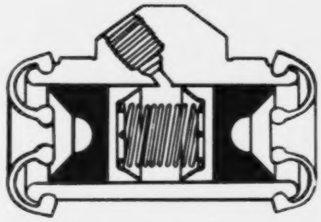
Label the basic components of the typical wheel cylinder illustrated below. Write the correct names in the blanks.



Used with permission of McGraw-Hill Book Company, Gregg Division, from *Automotive Mechanics*, 8th ed., by William H. Crouse, 1980.

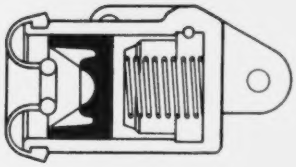
OBJECTIVE 13

Write the correct name for each of the types of wheel cylinders illustrated below.



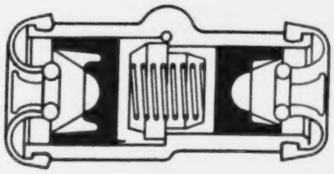
Used with permission of Allied Aftermarket.

a. ____



Used with permission of Allied Aftermarket.

b. ____



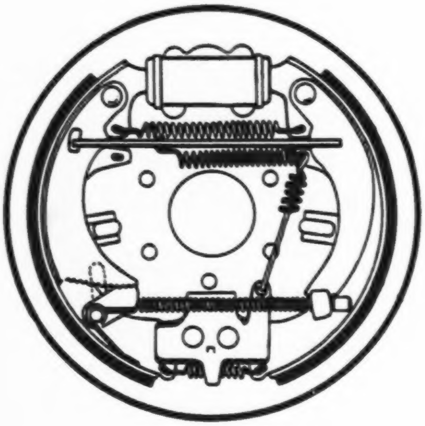
Used with permission of Allied Aftermarket.

c. ____

OBJECTIVE 15

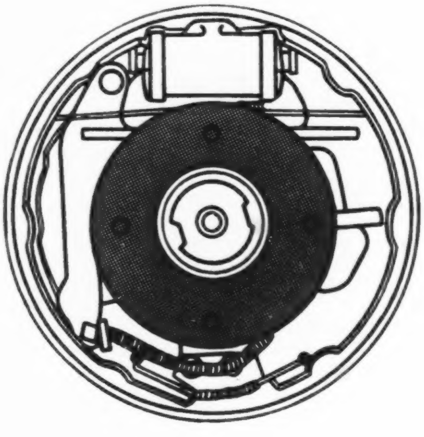
Choose from the list below the correct name for each of the types of drum brake shoe adjusters shown below and on the following pages, and write the correct names in the blanks.

Link (crank)
Rod-and-strut assembly
Cable
Eccentric cam
Ratchet
Lever



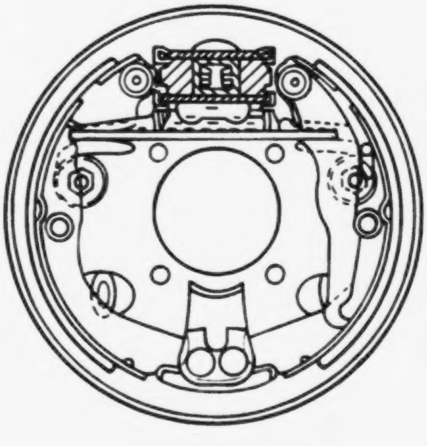
Used with permission of Ford Motor Company.

a. ____



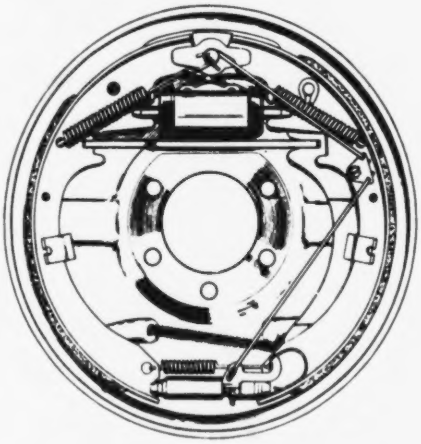
Used with permission of Allied Aftermarket.

b. ____



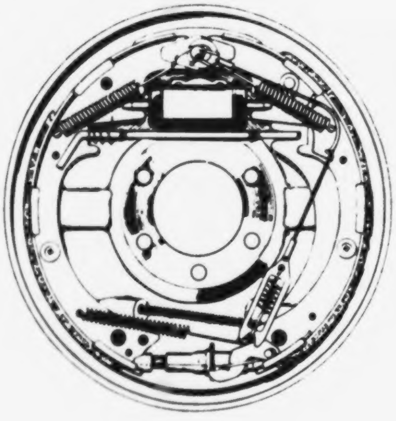
Used with permission of Allied Aftermarket.

c. ____



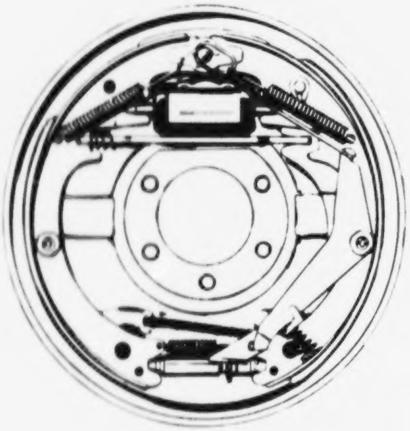
Used with permission of Allied Aftermarket.

d. ____



Used with permission of Allied Aftermarket.

e. ____



Used with permission of Allied Aftermarket.

f. ____

OBJECTIVE 18

Diagnose drum brake problems. Choose the statement below that best diagnoses each of the following drum brake problems. Write the correct numbers in the blanks.

______a. A customer brings in a late-model automobile, complaining that when she applied the brakes, the brake pedal goes to the floor. Which of the following would be the *most likely* cause?

1. Worn or damaged rear wheel bearings
2. Out-of-rounds drums
3. Weak shoe return springs or hold-downs
4. Excessive clearance between drums and linings

______b. You are servicing a customer's vehicle and find that the cause of a spongy pedal is air seeping into the wheel cylinders. Which of the following is the proper corrective action?

1. Replace residual pressure check valve
2. Replace shoes and linings in axle sets
3. Replace wheel cylinder
4. Replace retracting springs

______c. Which of the following conditions would be *most likely* to cause an automobile to pull to one side?

1. Air in brake system
2. Drum silencer spring missing or weak
3. Loose or distorted backing plates
4. Soft or swollen rubber parts

______d. Which of the following would be the *most likely* cause of brake squeal?

1. Rivets or shoe table rubbing on drum
2. Loose spindle or suspension parts
3. Threaded drum surface
4. Dust embedded in lining

______e. When servicing a vehicle, you find that the brake shoes are improperly adjusted, causing the brakes to drag. Which of the following would be the proper corrective measure?

1. Replace shoe return springs
2. Adjust shoes and repair automatic adjuster if necessary
3. Adjust anchor pin if provided
4. Replace shoes and automatic adjuster

______f. While performing a brake inspection, you find that the brakes drums are out-of-round. Which of the following is the *most likely* cause?

1. Wear and tear
2. Improper lug nut torque
3. Uneven shoe application
4. Collision impact

______g. When inspecting the brakes on a customer's vehicle, you find that the brake drums are cracked and broken. Which of the following is the *most likely* cause?

1. Excessive lining wear exposing rivet head or shoe steel
2. Uneven shoe application
3. Dragging parking brake
4. High operating temperature followed by rapid cooling

______h. Which of the following brake drum defects is caused by excessive lining wear, exposing rivet head or shoe steel?

1. Barrel shaped
2. Scoring
3. Hard spots and heat checks
4. Bell mouthed

NOTE: Turn in your test to your instructor, who will grade the test and determine whether additional training is needed.

WRITTEN TEST ANSWERS

SERVICE DRUM BRAKES

OBJECTIVE 1

a. 3
b. 3
c. 1
d. 2
e. 1
f. 3
g. 3
h. 2
i. 1
j. 2
k. 2
l. 3
m. 3
n. 1

OBJECTIVE 2

a. Used to back off star wheel for drum removal or for adjustment of lining-to-drum clearance
b. Used to remove and reinstall retracting and adjusting springs
c. Used to remove and reinstall hold-down springs
d. Used to machine friction surface of brake drums and to grind out hardened areas on drum
e. Used to clean brake lining dust from brake assembly; designed to protect technician from harmful asbestos fibers
f. Used to measure and adjust lining-to-drum clearance
g. Used to pry springs off anchor pin for removal and to stretch springs over anchor pin for reinstallation
h. Used to prevent hydraulic pressure from pushing wheel cylinder pistons and cups too far out in bore when brake shoe retracting springs are removed
i. Used to recondition wheel cylinder bore
j. Used to open and close wheel cylinder bleeder screws
k. Used to measure drum diameter

OBJECTIVE 3

1. Brake pedal is depressed, generating hydraulic pressure in master cylinder
2. Hydraulic pressure from master cylinder is transmitted to wheel cylinder
3. Wheel cylinder pistons push brake shoes against rotating drum
4. Shoes try to rotate with drum, producing a wedging action that helps press the linings into firmer contact with drum
5. Friction between brake shoe and brake drum slows or stops rotation of wheel

OBJECTIVE 4

Duo-servo assembly

a. Retaining spring
b. Primary shoe
c. Hold-down assembly
d. Spindle
e. Primary shoe retracting spring
f. Backing plate
g. Anchor pin
h. Anchor plate
i. Secondary shoe retracting spring
j. Wheel cylinder
k. Secondary shoe
l. Star-wheel adjuster

Non-servo assembly

a. Anchor
b. Retaining spring
c. Forward shoe
d. Retracting spring
e. Wheel cylinder
f. Star-wheel adjuster
g. Hold-down cup and spring
h. Reverse shoe

OBJECTIVE 5

a. 8
b. 1
c. 5
d. 7
e. 3
f. 6
g. 2
h. 9
i. 4

OBJECTIVE 6

a. 11
b. 12
c. 3
d. 2
e. 6
f. 9
g. 4
h. 1
i. 10
j. 8
k. 5
l. 7

OBJECTIVE 7

Answers should include at least three defects for each test item *a* through *f*.

a. Cracks, glazing, fluid or grease contamination, uneven wear
b. Hot spots, scoring, cracking, out-of-round, oversize
c. Cracks or warpage, pads for ridges, pads for steps, lack of lubrication
d. Wallowing of retainer holes, loose springs, improper installation of spring nails or retainers
e. Overheating, stretching, distortion, nicks
f. Missing or damaged parts, improper installation, frayed adjusting cables, rounded-off star wheels, damaged cable guides, damaged adjusting levers, frozen adjusting screws

OBJECTIVE 10

a. Double-anchor double-cylinder
b. Single-anchor self-centering

OBJECTIVE 12

a. Piston
b. Boot
c. Piston cup
d. Spring
e. Cylinder body
f. Brake shoe actuating pin

OBJECTIVE 13

a. Double-piston straight-bore
b. Single-piston
c. Double-piston step-bore

OBJECTIVE 15

a. Ratchet
b. Rod-and-strut assembly
c. Eccentric cam
d. Link (crank)
e. Cable
f. Lever

OBJECTIVE 18

a. 4
b. 1
c. 3
d. 1
e. 2
f. 3
g. 4
h. 2

OBJECTIVE SHEET

UNIT 3 SERVICE DISC BRAKES

INTRODUCTION

Many different brake systems are used by today's automobile manufacturers. While the majority of today's American automobiles have front disc brakes and rear drum brakes, some late-model General Motors and Chrysler automobiles and a number of foreign models are equipped with four-wheel disc brakes.

Disc brakes are generally used on the front wheels because they have more braking force than drum brakes. Disc brake calipers convert brake fluid pressure and volume into a clamping force. The clamping force of the front-wheel brakes provides 60 to 85 percent of the total stopping torque of the vehicle. Front-wheel disc brakes provide the most braking power and the least fade resistance where traction is the greatest in hard stopping.

UNIT OBJECTIVE

After completing this unit, the student should be able to diagnose disc brake problems and service disc brake systems. The student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

PREREQUISITES

Before studying this unit, the student should have successfully completed Unit 1, "Service Brake Hydraulic System and Wheel Bearings."

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to

1. Recognize definitions of terms associated with disc brakes by choosing the correct definitions from lists of three choices.

2. Recall specialty tools used to service disc brakes by writing the name of the tool when given an illustration.

3. Recall the steps of disc brake operation by listing the steps in order when given a numbered illustration.
4. Recall descriptions of types of disc brake calipers by writing the correct descriptions of each.
5. Recall the parts of a typical floating caliper assembly by labeling the parts on an illustration.
6. Recall the advantages of disc brake design by writing the advantages.
7. Remove, clean, inspect, and reinstall caliper assembly and brake pads. (Job Sheet 1)
8. Recondition a disc brake caliper. (Job Sheet 2)
9. Clean, inspect, and measure a rotor with dial indicator and micrometer. (Job Sheet 3)
10. Resurface a rotor. (Job Sheet 4)
11. Recognize types of parking brakes used on vehicles with rear disc brakes by matching illustrations of types of parking brakes to their correct descriptions.
12. Overhaul and adjust rear disc/drum (auxiliary drum) parking brake. (Job Sheet 5)
13. Overhaul Kelsey-Hayes-type rear disc brake/parking brake assembly. (Job Sheet 6)
14. Overhaul GM Delco-Moraine-type rear disc brake/parking brake assembly. (Job Sheet 7)
15. Diagnose disc brake problems. (Assignment Sheet 1)

SUGGESTED ACTIVITIES

SERVICE DISC BRAKES

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section. Include in your selection media that demonstrate job-sheet skills. Videotape your own demonstrations of job-sheet procedures if unable to obtain suitable media.
- Obtain transparencies and competency profiles for this unit.
- Prepare classroom and shop. Display posters, charts, safety signs, etc., related to disc brake service. Have articles, specification guides, mock-ups, component displays, and other disc brake service resource material available for student reference. Display various disc brake calipers and related hardware.
- Discuss with students the purpose of pretesting. Explain that they will be asked to complete a written pretest and that they will be required to demonstrate assignment-sheet competencies and job-sheet skills as part of the pretesting process.
- Provide students with equipment and materials necessary to complete pretest. Administer pretest.
- Assess student competencies. Consider results of student assessments of the unit objectives as you prepare your presentation for each objective.

DELIVERY

- Discuss introduction to the unit (see Objective Sheet).
- Discuss the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives will lead to meeting the unit objective and how reaching the unit objective is vital to becoming an automotive brakes specialist. Also relate the objectives to your introduction and to materials previously covered.

- Discuss the evolution of disc brakes, and show filmstrip, *Disc Brake Service*, as an overview of the unit.

- Use Transparency 1, "Major Components of a Disc Brake System," to introduce students to the typical components of a tandem dual brake system with rear drum and front disc brakes.

- Display Bendix *Brake System Schematic* and Thiokol wall chart and use to supplement your discussion of disc brakes as applicable.

- Review asbestos safety, stressing the absolute necessity for avoiding inhalation of asbestos particles.

- Tour the shop, pointing out equipment and materials used in servicing disc brakes.

Objective 1 Recognize definitions of terms associated with disc brakes

- Point out examples in the shop of appropriate terms, and make examples available in the classroom.

- Show samples of various types of disc brakes.

- Show students examples of scoring and scuffing.

- Show students the vane on a ventilated disc brake. Discuss how the vanes on such a brake help to dissipate heat.

- Show students the locations of inboard and outboard shoes.

- Illustrate the term *friction* by having students rub their thumb and index fingers together without and then with a drop of oil applied. Use sandpaper and a soft substance to illustrate how friction causes wear.

- Discuss the box material presented with this objective.

- Have students complete Supplement 1, "Disc Brakes Crossword Puzzle," as a review of these terms.

Objective 2 Recall specialty tools used to service disc brakes

- Show students an example of each of the tools listed in this objective, and demonstrate the use of each of the tools, allowing students to return the demonstration.

- Show students a drum brake lathe, and demonstrate how it can be adapted for machining disc brakes.

- Show students an enclosure-type brake cleaner; and review its installation and its importance in asbestos containment.

- Discuss the care and maintenance of each tool, and show students the proper shop storage location for each of the tools. Stress the need for returning tools to proper storage.

- Where applicable, show students alternative tools that may be used to accomplish a task.

  EXAMPLE: Using channel-lock pliers to remove a dust cap

Objective 3 Recall the steps of disc brake operation

- Discuss braking action in general, reviewing hydraulic principles and friction.

- Make a mock-up so that students may view the sequence of disc brake operation.

- Discuss disc brake operation on four-wheel disc brake vehicles.

- Provide students with AC-Delco brochures, *Four Piston Disc Brakes* and *Single Piston Disc Brakes*.

- Compare disc brake shoe action to the braking action that occurs on a ten-speed bicycle.

- Use Transparency 1, "Major Components of a Disc Brake System," to illustrate your discussion of disc brake operation.

Objective 4 Recall descriptions of types of disc brake calipers

- Show students examples of each type of caliper illustrated in this objective.

- Point out that caliper names indicate the movement allowed or disallowed by the mounting technique.

- Use Transparencies 2 through 4 to illustrate your discussion.

- Discuss reasons for single- and multiple-piston designs.

- Provide students with technical bulletin *Disc Brake Caliper Assemblies* for future reference.

- Provide students with Supplement 2, "Types of Disc Brake Caliper Assemblies." Discuss with the class.

Objective 5 Recall the parts of a typical floating caliper assembly

- Display a disassembled floating caliper assembly and allow students to examine its components.
- Show students a floating caliper assembly mounted on a vehicle.
- Use Transparency 2, "Parts of a Floating Caliper Disc Brake Assembly," to point out the parts of the floating caliper disc brake assembly.
- Provide students with technical bulletin *Disc Brake Caliper Assemblies* for future reference.
- Provide students with Supplement 2, "Types of Disc Brake Caliper Assemblies," and discuss those that are of the floating caliper design.
- Pair students and have teams quiz each other on the names of the parts of a floating caliper.

Objective 6 Recall the advantages of disc brake design

- Review and discuss the advantages of disc brake design.
- Discuss the box material, "Disc Brake Design Features."
- Show students how the design of the disc brake makes it more resistant than the drum brake to heat and water fade.
- Discuss the correct use of an inspection report form such as Supplement 3, "Brake System Inspection Report Form," or similar form, and provide students with copies for them to use while practicing inspection procedures.
- Discuss the equipment and materials used in Job Sheets 1 through 3. Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introductions.
- Show and discuss media presentations, "Repair Sliding Caliper Disc Brake" and "Check Disc Runout and Thickness," or other appropriate media.
- Review installation of brake cleaner and asbestos safety rules.

- Demonstrate caliper bore honing techniques.

- Allow students to practice using a dial indicator and micrometer.

- Demonstrate Job Sheets 1 through 3. Have students practice Job Sheet 1 through 3 until they are ready to take the practical tests.

- Discuss equipment and materials used in Job Sheet 4, "Resurface a Rotor." Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introduction. Show and discuss appropriate media.

- Demonstrate how to adapt a drum lathe for disc brake use.

- Demonstrate Job Sheet 4. Have students practice Job Sheet 4 until they are ready to take the practical test.

Objective 11 Recognize types of parking brakes used on vehicles with rear disc brakes

- Show students examples of each type of parking brake on various makes and models of vehicles.

- Display disassembled examples of each type of parking brake. Name and discuss each of the components to familiarize students with the parts of each.

- Use Transparencies 5 through 7 to illustrate your discussion of parking brake types.

- Provide students with examples of vehicles equipped with these types of parking brakes.

  EXAMPLE: All Corvettes since 1965 and some Camaros and Imperials since 1974 have four-wheel disc brakes and auxiliary drum parking brakes.

- Show and discuss media presentation, *Servicing Parking Brakes*, or other appropriate media.

- Discuss the equipment and materials used in Job Sheets 5 through 7. Review with students applicable safety rules and precautions and the guidelines given in the job-sheet introductions.

- Demonstrate Job Sheets 5 through 7. Have students practice Job Sheets 5 through 7 until they are ready to take the practical tests.

- Provide students with Lee *Disc Brake Troubleshooting Guide* and Niehoff *Diagnosing Brake Squeal* bulletins to use as diagnostic references.
- Have students study Student Supplement 1, "Troubleshooting Chart for Disc Brakes," and then complete Assignment Sheet 1, "Diagnose Disc Brake Problems."

Unit summary activities

- Discuss Activity Sheet 1, "Answer General Questions About Disc Brakes." The purpose of this activity is to provide students with the opportunity to practice answering questions similar in content and style to those found on the actual ASE certification test. Keep this in mind when discussing the assignment.
- Have students complete Activity Sheet 1.
- Discuss Activity Sheet 2, "Interpret Service Manual Diagnostic Charts." The purpose of this activity is to provide students with practice in using service-manual charts to diagnose disc brake problems. Keep this in mind when discussing the assignment.
- Have students complete Activity Sheet 2.

EVALUATION

- Give written test.
- Give practical tests, providing students with copies of Supplement 3, "Brake System Inspection Report Form," or similar form to be completed as part of the practical tests. Evaluate tests on forms provided.
- Reteach and retest as required.
- Complete appropriate section of competency profiles.

SUGGESTED RESOURCES

Resources used in developing unit

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 2: Front Disc Brake Service*. Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Basic Car Care*, 2nd ed. New York: Hearst Corporation, 1980.
- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual*. Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.

- Billiet, Walter E., and Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.

- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985*. Radnor, Pennsylvania: Chilton Book Company, 1984.

- Coghlan, David A. *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed. Boston: Breton Publishers, A Division of Wadsworth, Inc., 1985.

- Crouse, William H., and Donald L. Anglin. *Automotive Mechanics*, 9th ed. New York: Gregg Division, McGraw-Hill Book Company, 1985.

- Henderson, Chuck, and Ivan Armstrong. *Auto Mechanics I*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

- Hughes, James G. *Guide to Automobile Certification Examination*, revised ed. Reston, Virginia: Reston Publishing Company, Inc., a Prentice-Hall Company, 1983.

- *Mitchell Chassis Service & Repair Domestic Cars: 1985 Supplement*. San Diego, California: Mitchell Information Services, Inc., a Cordura Company, 1985.

- *1986 New Model Highlights and Service Features: Domestic and Import*. Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1985.

- *1986 Chrysler Engine-Chassis-Body Service Manual: 1986 Front Wheel Drive Passenger Vehicles Lancer, Daytona, New Yorker, Dodge 600, Aries, Omni, LeBaron GTS, LeBaron, Caravelle, Reliant, Horizon*. Centerline, Michigan: Chrysler Corporation, 1985.

- *1986 Shop Manual: Caprice, Monte Carlo, El Camino*. Detroit, Michigan: General Motors Corporation, Chevrolet Motor Division, 1986.

- *Raybestos Brake Service Manual for Passenger Cars: Drum and Disc Brakes*. Bridgeport, Connecticut: Division of Raybestos Manhattan, 1970.

- Remling, John. *Brakes*, 2nd ed. New York: John Wiley and Sons, Inc., 1978.

- Stockel, Martin W., and Martin T. Stockel. *Auto Mechanics Fundamentals.* South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1982.

- Toboldt, William K., and Larry Johnson. *Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair.* South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1983.

- *Wagner Manual AU-1600/Feb., 1984: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual.* Parsippany, New Jersey: Wagner Division, McGraw-Edison Company, 1984.

- *Wagner Manual AU-1600: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual.* Parsippany, New Jersey: Wagner Division, Cooper Industries, Inc., 1988.

Media

- *Automotive Tech Series: Caliper Overhaul.* 37 minutes, VHS, Beta 1 or Beta 2 videotapes.

- *Automotive Tech Series: Using the Disc and Drum Micrometer.* 27 minutes, VHS, Beta 1 or Beta 2 videotape.

- *Automotive Tech Series: Servicing Parking Brakes.* 10.15 minutes, VHS, Beta 1 or Beta 2 videotape.

- *GM X-Body Brake Service*, "Disc Brakes: Removal" and "Disc Brakes: Assembly." 2 cassettes, 2 filmstrips, and instructor's guide.

- *Disc Brake Service.* 1 filmstrip, 1 cassette.

NOTE: These first five media presentations are available from Teaching Aids Incorporated, Post Office Box 1798, Costa Mesa, California 92628-0798.

- *The Hydraulic Brake System Explained: How to Reline Disc-Type Brakes.* 7-14 minutes VHS videotape.

- *The Hydraulic Brake System Explained: Servicing the Hydraulic System—Disc Type.* 7 minutes each, VHS videotapes. Available from National Innovative Media Company, Route 2, Box 301B, Calhoun, Kentucky 42327, call toll-free 800-962-6662. These media may also be obtained as filmstrips and cassettes.

- *Drum and Disc Brake Service.* 24 minutes, 113 slides/audio. Available from Wagner Division, McGraw-Edison Company, 6400 Plymouth Avenue, St. Louis, Missouri 63133.

- *Service Disc Brakes*. Videotape, color, includes "Repair Sliding Caliper Disc Brake" and "Check Disc Runout and Thickness." Available from the Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

NOTE: The following two sound filmstrips are part of a series titled *Hydraulic Brake Service* and are available from Vocational Media Associates/Prentice-Hall Media, P.O. Box 1050, Mount Kisco, New York 10549-9989.

- *Hydraulic Brake Service: Removing and Replacing Disc Brake Pads*. 1 sound filmstrip

- *Hydraulic Brake Service: Replacing Seals in a Single-Piston Caliper*. 1 sound flimstrip

Print media

- *Four Piston Disc Brakes* and *Single Piston Disc Brakes*. Manuals available free from AC-Delco, General Motors Corporation, 400 Renaissance Center, Detroit, Michigan 48243.

- *Disc Brake Caliper Assemblies*. A technical bulletin available free from Autoline, 840 West 31st Street, Chicago, Illinois 60608.

- *Brake System Schematic*. Available free from Bendix Automotive Aftermarket, 1094 Bendix Drive, Jackson, Tennessee 38301.

- *Semi-Metallic Pads, Including Gritiron & Metalist Brands* and *Installation Instructions for Disc Brake Pads*. Available free from The Guardian Corporations, Communication Department, 145 N. Beacon Street, Brighton, Massachussetts 02135.

- Lee *Disc Brake Trouble Shooting Guide* and Lee *Disc Brake Assemblies Wall Chart*. Available free from Lee Manufacturing Company, Division of Rolero, Incorporated, 4933 East 154th Street, Cleveland, Ohio 44128.

- *Diagnosing Brake Squeal* and *Disc Caliper Repair*. Unbound technical bulletins available free from C. E. Niehoff & Company, Division of TRW, Inc., 4925 Lawrence Avenue, Chicago, Illinois 60630.

- Thiokol *Passenger Car Application/Identification* wall chart. Available free from Thiokol Corporation, Friction Division, P.O. Box 8296, North Enterprise Avenue, Trenton, New Jersey 08650.

- Transparencies and competency profiles

  NOTE: Transparencies and competency profiles for this manual are available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

SERVICE DISC BRAKES

SUPPLEMENT 1

Disc Brakes Crossword Puzzle

Use the clues below and your knowledge of disc brakes to complete the crossword puzzle on the following page.

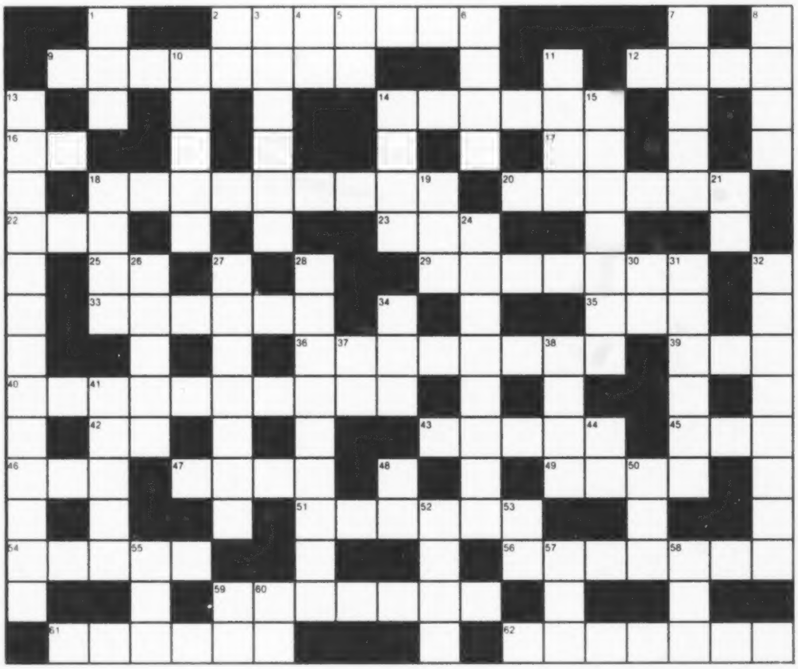
ACROSS

2. Type of caliper
9. Type of caliper
12. Thin bridge between two disc surfaces
14. May be drum or disc
16. Electrical engineer (abbr)
17. Alternating current (abbr)
18. With 14 Down, tool used to reduce noise during machining of rotor
20. What the circuit is when the stoplights are on
22. Rodent
23. Mom and ---
25. Time -- our lives
29. Metal sleeve
33. May be one, two, or four in caliper
35. Neither, ---
36. Effects of excessive heat on drum brakes
39. Consume
40. Type of parking brake that is integral part of service brake
42. Road (abbr)
43. Disc
45. Standing room only (abbr)
46. Automotive Service Excellence (abbr)
47. Condition that could be caused by unmatched linings
49. Short written message
51. Part of 18 Down and 59 Across
54. Opposite of *inner*
56. Shoe on vehicle frame side of brake disc
59. Type of brake light
61. Free ------; pedal play
62. Viselike part that grips rotor

DOWN

1. Sunshine state (abbr)
2. Street (abbr)
3. Brake pad
4. Opposite of *out*
5. Dating Game (abbr)
6. Condition that may result from power brake malfunction
7. Tool used to check vacuum supply
8. Possible result of faulty seals
10. Eat one of these a day to keep the doctor away
11. With 31 Down, another name for dust cap or dust cover
13. Metal tab that contacts rotor and squeals when lining wears to point where it needs to be replaced
14. With 18 Across, tool used to reduce noise when rotor is machined
15. Wear damage from multiple scratches
18. Opposite of *go*
19. Chit-chat
21. Opposite of *don't*
24. Component that prevents dirt and dust from entering piston
26. Type of caliper
27. Footrest hung from a saddle
28. With 33 Across, type of tool for positioning a piston
30. Negative word
31. With 11 Down, another name for dust cap or dust cover
32. Shoe on wheel cover side of brake disc
34. Push---; part that forces primary piston in master cylinder forward
37. Physical education (abbr)
38. Twelve o'clock
41. Trick or -----
44. Runout (abbr)
48. Large (abbr)
50. Also
52. Tool used to recondition cylinder bore
53. Spanish "yes"
55. Equal Rights Amendment (abbr)
57. Firearms group
58. Tall mountain
59. Us
60. -- Capone

Disc Brakes Crossword Puzzle



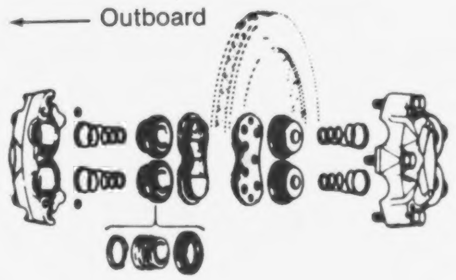
Solution to Disc Brakes Crossword Puzzle

■	■	1 F	■	■	2 S	3 L	4 I	5 D	I	N	6 G	■	■	■	■	7 G	■	8 L
■	9 F	L	O	10 A	T	I	N	G	■	■	R	■	11 S	■	12 V	A	N	E
13 W	■	A	■	P	■	N	■	■	14 B	R	A	K	E	15 S	■	U	■	A
16 E	E	■	■	P	■	I	■	■	A	■	B	■	17 A	C	■	G	■	K
A	■	18 S	I	L	E	N	C	I	N	19 G	■	20 C	L	O	S	E	21 D	■
22 R	A	T	■	E	■	G	■	■	23 D	A	24 D	■	■	R	■	■	O	■
I	■	25 O	26 F	■	27 S	■	28 I	■	■	29 B	U	S	H	I	30 N	31 G	■	32 O
N	■	33 P	I	S	T	O	N	■	34 R	■	S	■	■	35 N	O	R	■	U
D	■	■	X	■	I	■	36 S	37 P	O	T	T	I	38 N	G	■	39 E	A	T
40 I	N	41 T	E	G	R	A	T	E	D	■	B	■	O	■	■	A	■	B
C	■	42 R	D	■	R	■	A	■	■	43 R	O	T	O	44 R	■	45 S	R	O
46 A	S	E	■	47 P	U	L	L	■	48 L	■	O	■	49 N	O	50 T	E	■	A
T	■	A	■	■	P	■	51 L	I	G	52 H	T	53 S	■	■	O	■	■	R
54 O	U	T	55 E	R	■	■	E	■	■	O	■	56 I	57 N	B	O	58 A	R	D
R	■	■	R	■	59 W	60 A	R	N	I	N	G	■	R	■	■	L	■	■
■	61 T	R	A	V	E	L	■	■	■	E	■	62 C	A	L	I	P	E	R

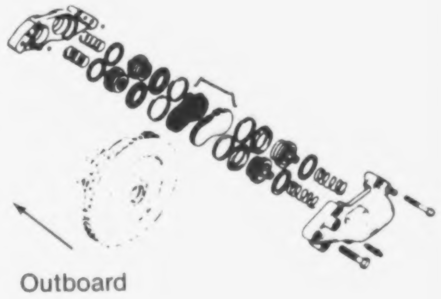
SUPPLEMENT 2

Types of Disc Brake Caliper Assemblies

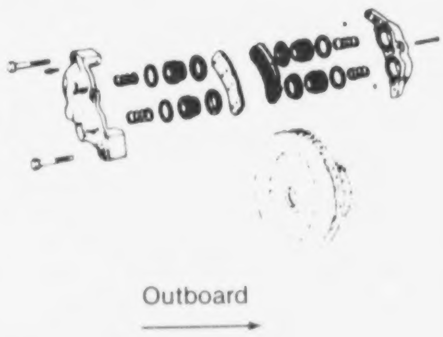
Fixed caliper (Bendix)



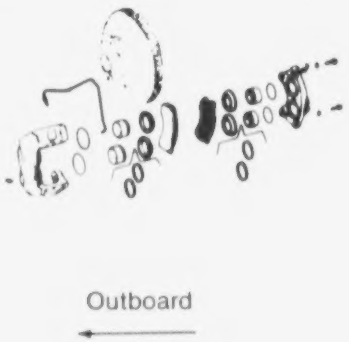
Fixed caliper (Budd)



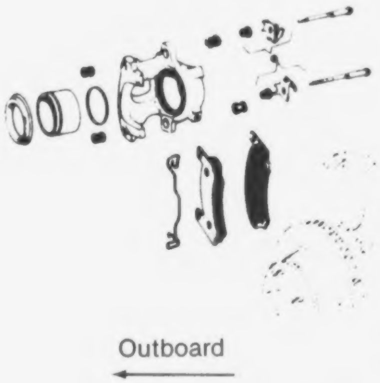
Fixed caliper (Delco Moraine)



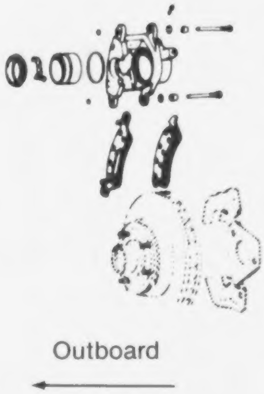
Fixed caliper (Kelsey-Hayes)



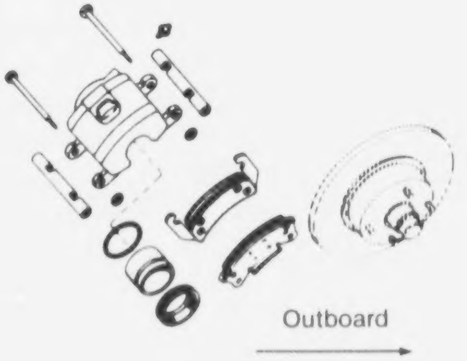
Floating caliper (Kelsey-Hayes)



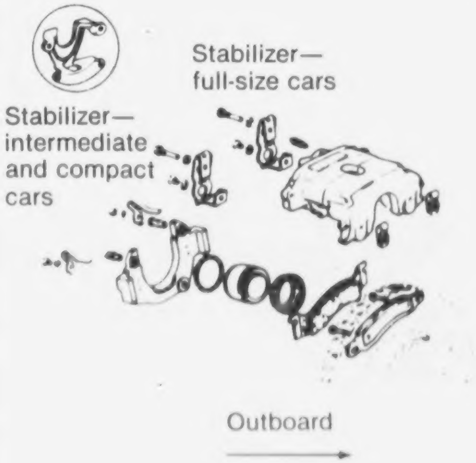
Floating caliper (Delco Moraine)



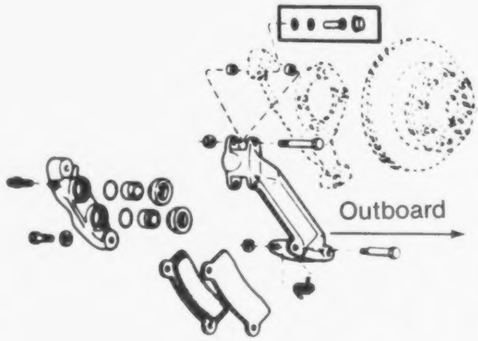
Floating caliper (Delco Moraine)



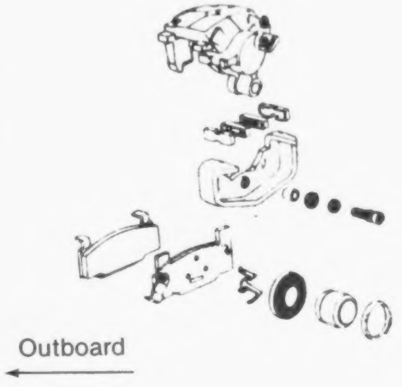
Floating caliper (Kelsey-Hayes)


Stabilizer—
full-size cars
Stabilizer—
intermediate
and compact
cars
Outboard

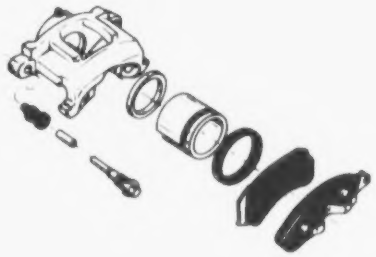
Two-piston floating caliper (Dayton)



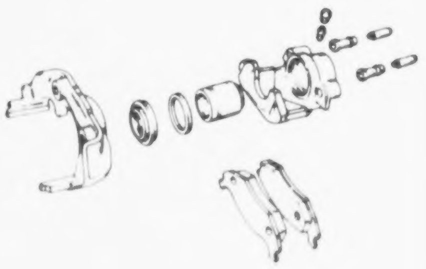
Floating caliper (Delco Moraine)

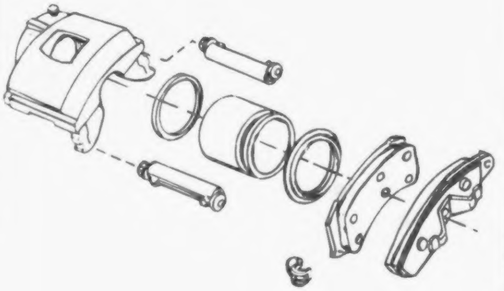


Floating caliper (Ford)

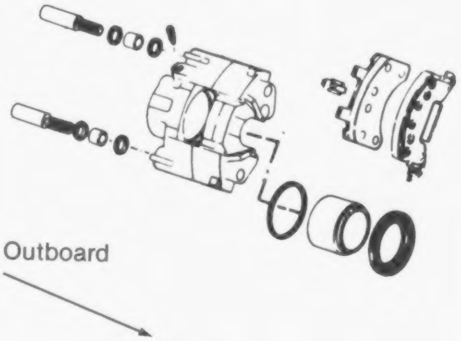


Floating caliper (Kelsey-Hayes)

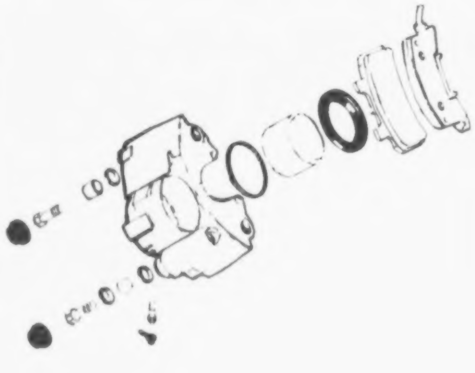




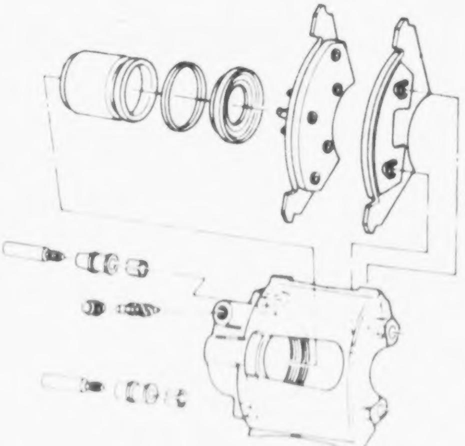
Floating caliper



Floating caliper (Delco Moraine)

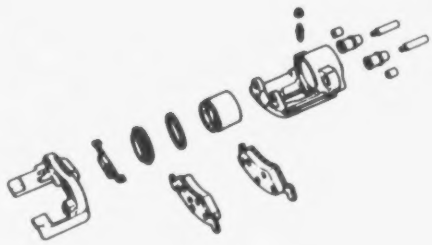


Floating caliper

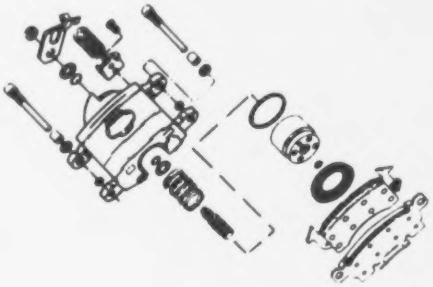


Floating caliper (Delco Moraine)

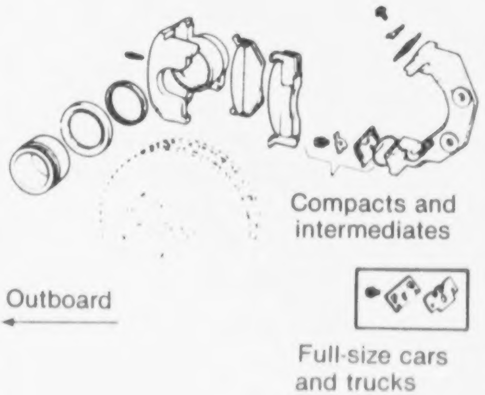
Floating caliper



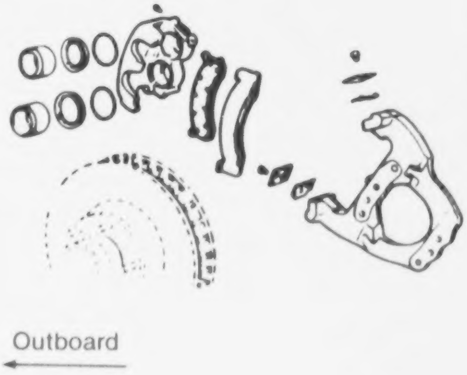
Floating caliper with parking brake (Delco Moraine)



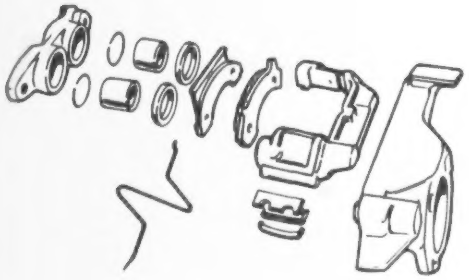
Sliding caliper (Chrysler)


Compacts and intermediates
Outboard
Full-size cars and trucks

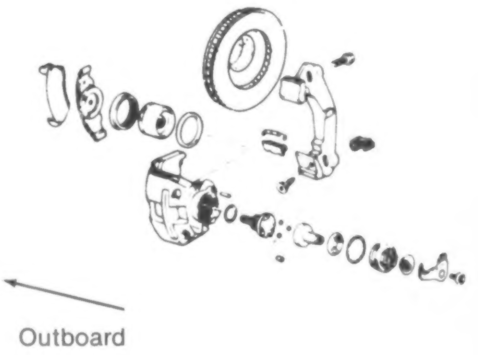
Two-piston sliding caliper (Kelsey-Hayes)



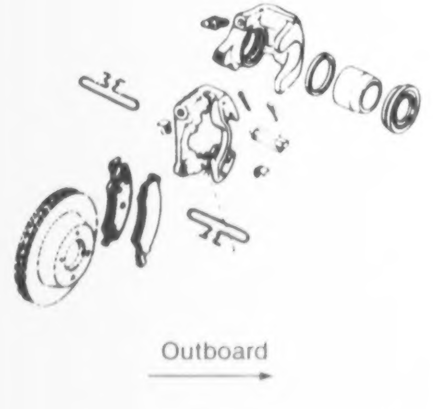
Sliding caliper (Dayton)



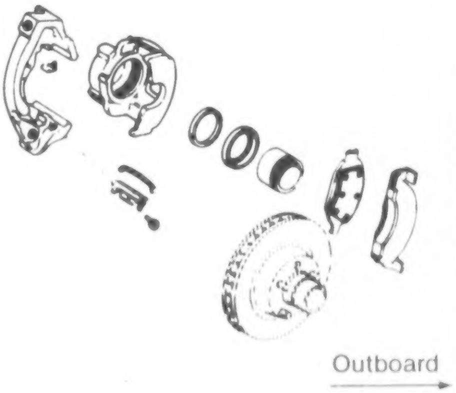
Sliding caliper with parking brake (Kelsey-Hayes)



Sliding caliper (Bendix)



Sliding caliper (Bendix, Kelsey-Hayes)



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INSTRUCTOR'S SUPPLEMENTS

SERVICE DISC BRAKES

SUPPLEMENT 3

Brake System Inspection Report Form

Customer name ______________________________

Address ____________ Telephone number: Work ____________ Home ____________

Vehicle make ____________ Year ____________ Mileage ____________

License number ______________________________

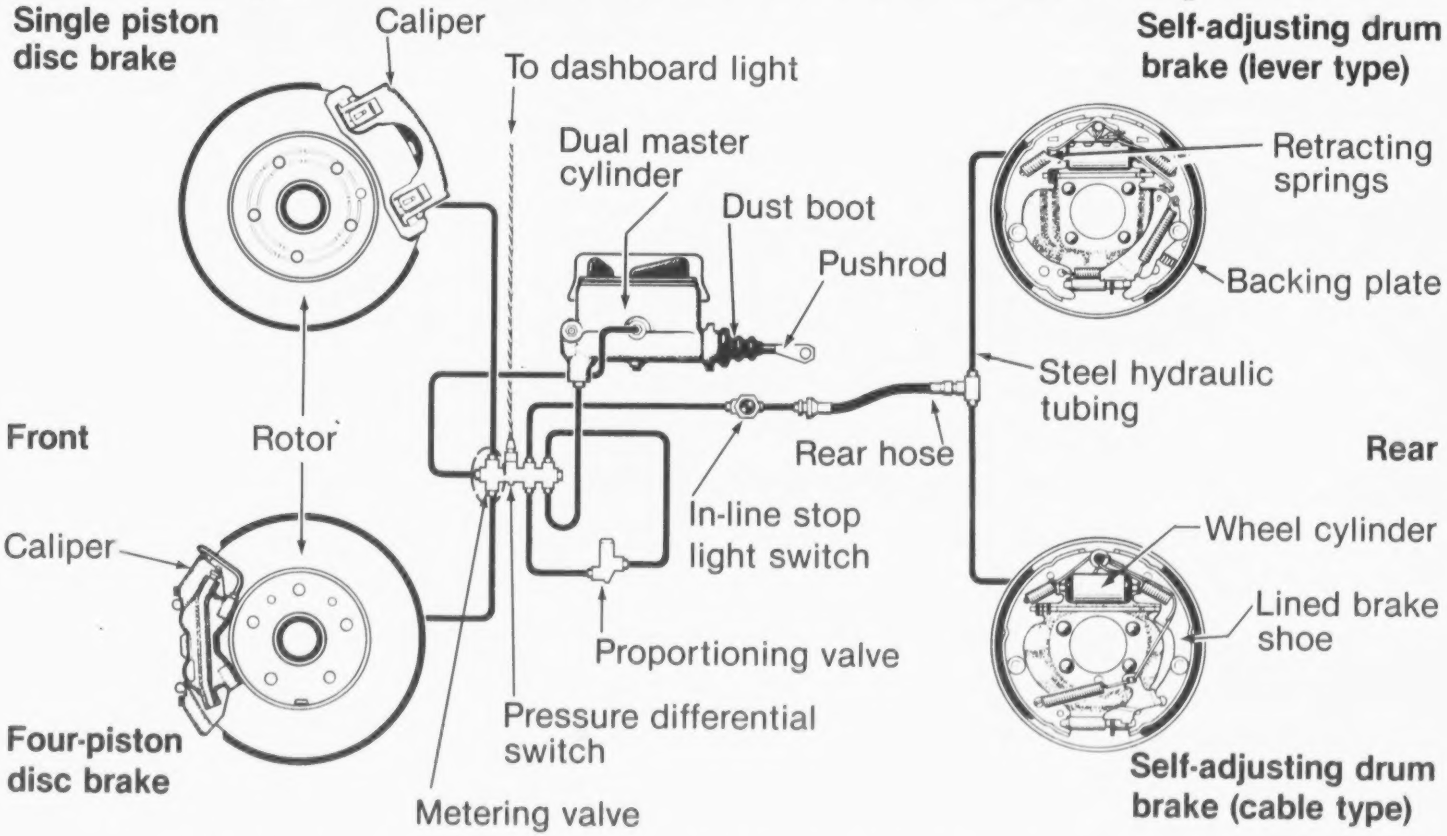
Approximate time required for service ______________________________

Inspected by ______________________________ Date ____________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate** Parts	Labor
Disc pads	☐ Semi-metallic ☐ Conventional		
Disc caliper	☐ Recondition ☐ Replace		
Disc hardware	☐ Replace		
Disc rotor	☐ Recondition ☐ Replace		
Grease seals	☐ Replace		
Front wheel bearings	☐ Repack ☐ Replace		
Wheel cylinders	☐ Recondition ☐ Replace		
Rear brake hardware	☐ Replace		
Brake shoes	☐ Replace		
Brake drums	☐ Recondition ☐ Replace		
Parking brakes	☐ Adjust ☐ Lubricate ☐ Replace		
Power brake booster	☐ Service ☐ Replace		
Master cylinder	☐ Recondition ☐ Replace		
Brake fluid	☐ Drain old, and add new fluid		
Lines, hoses, combination valve	☐ Replace		
Stop light, warning light	☐ Replace bulb ☐ Replace switch ☐ Adjust ☐ Replace		
Other ____________			
	Total		

Major Components of a Disc Brake System

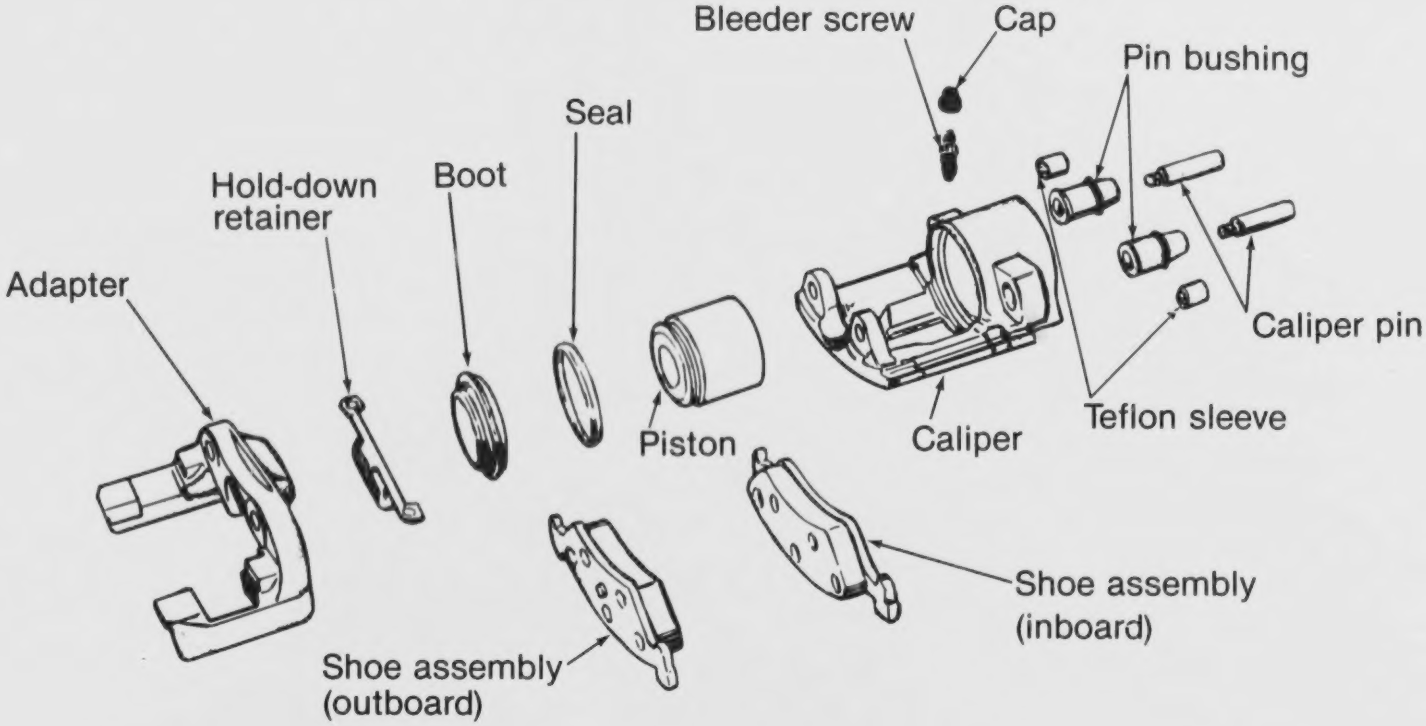


Single piston disc brake
Caliper
To dashboard light
Dual master cylinder
Dust boot
Pushrod
Self-adjusting drum brake (lever type)
Retracting springs
Backing plate
Steel hydraulic tubing
Front
Rotor
Rear hose
Rear
In-line stop light switch
Caliper
Wheel cylinder
Lined brake shoe
Proportioning valve
Pressure differential switch
Four-piston disc brake
Self-adjusting drum brake (cable type)
Metering valve

NOTE: Four different brake designs are illustrated in this transparency. In practice, brakes are paired, front or rear.

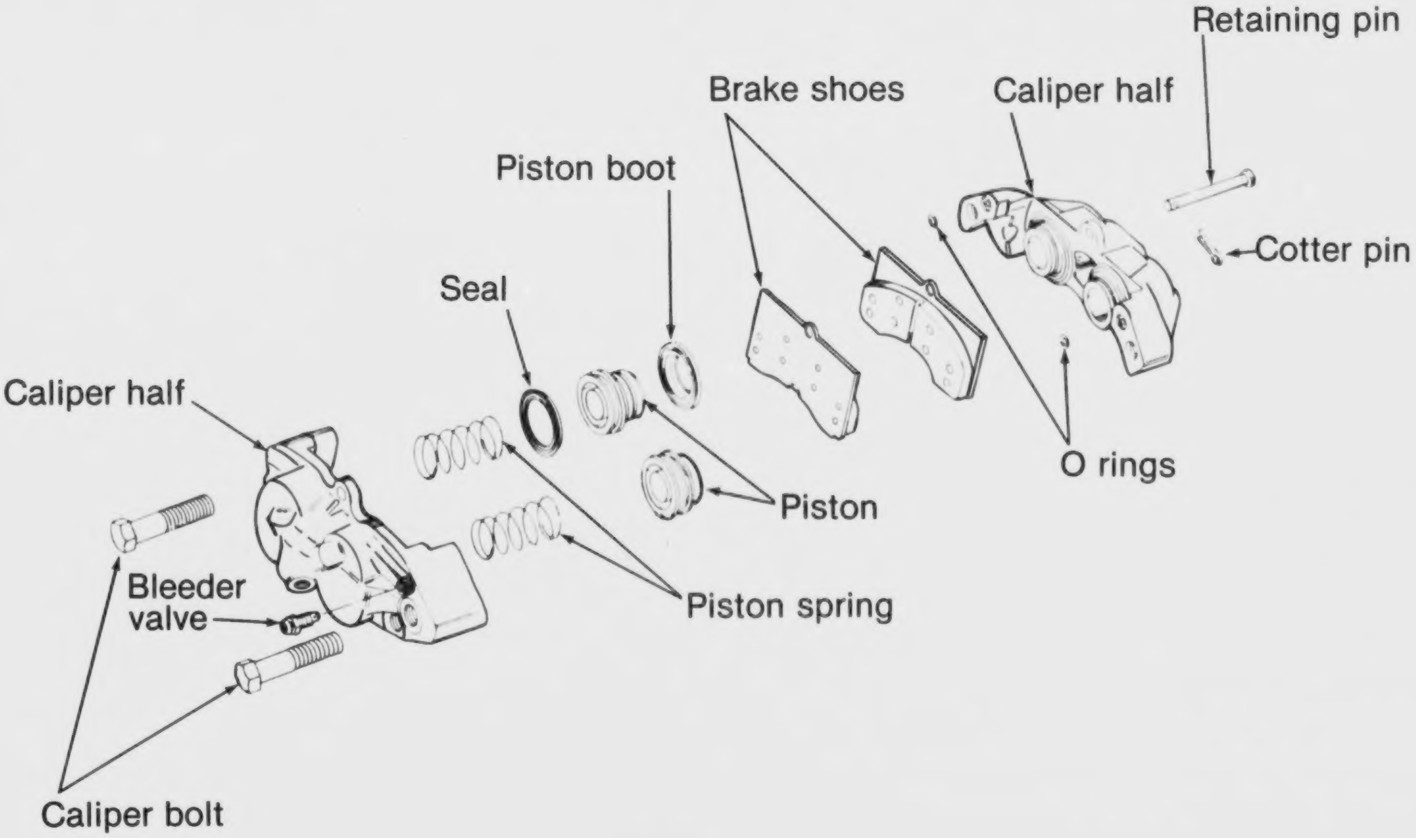
Used with permission of Raybestos/Brake Systems, Inc.

Parts of a Floating Caliper Disc Brake Assembly


Bleeder screw
Cap
Pin bushing
Seal
Hold-down retainer
Boot
Adapter
Caliper pin
Piston
Caliper
Teflon sleeve
Shoe assembly (inboard)
Shoe assembly (outboard)

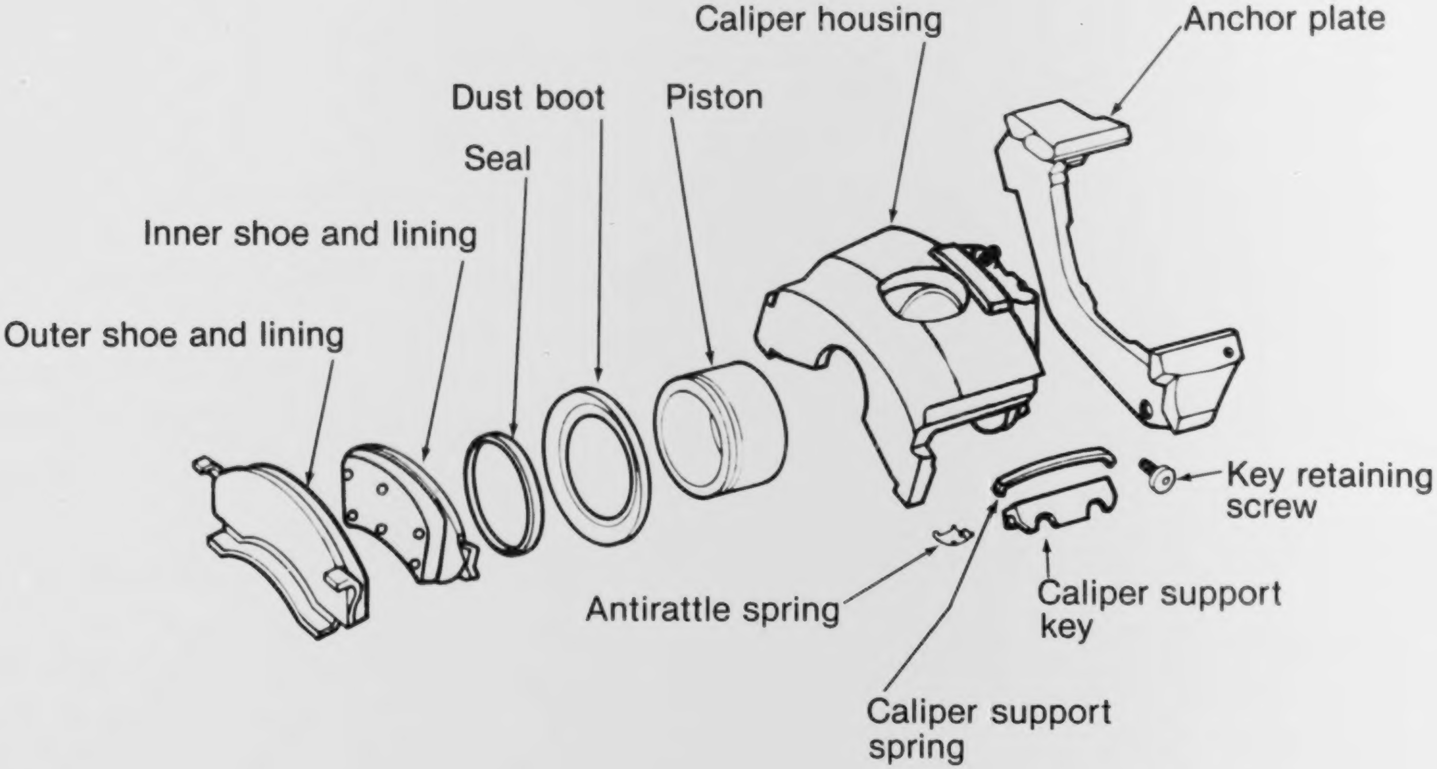
Used with permission of Chrysler Corporation.

Parts of a Fixed Caliper Disc Brake Assembly


Retaining pin
Brake shoes
Caliper half
Piston boot
Cotter pin
Seal
Caliper half
O rings
Piston
Bleeder valve
Piston spring
Caliper bolt

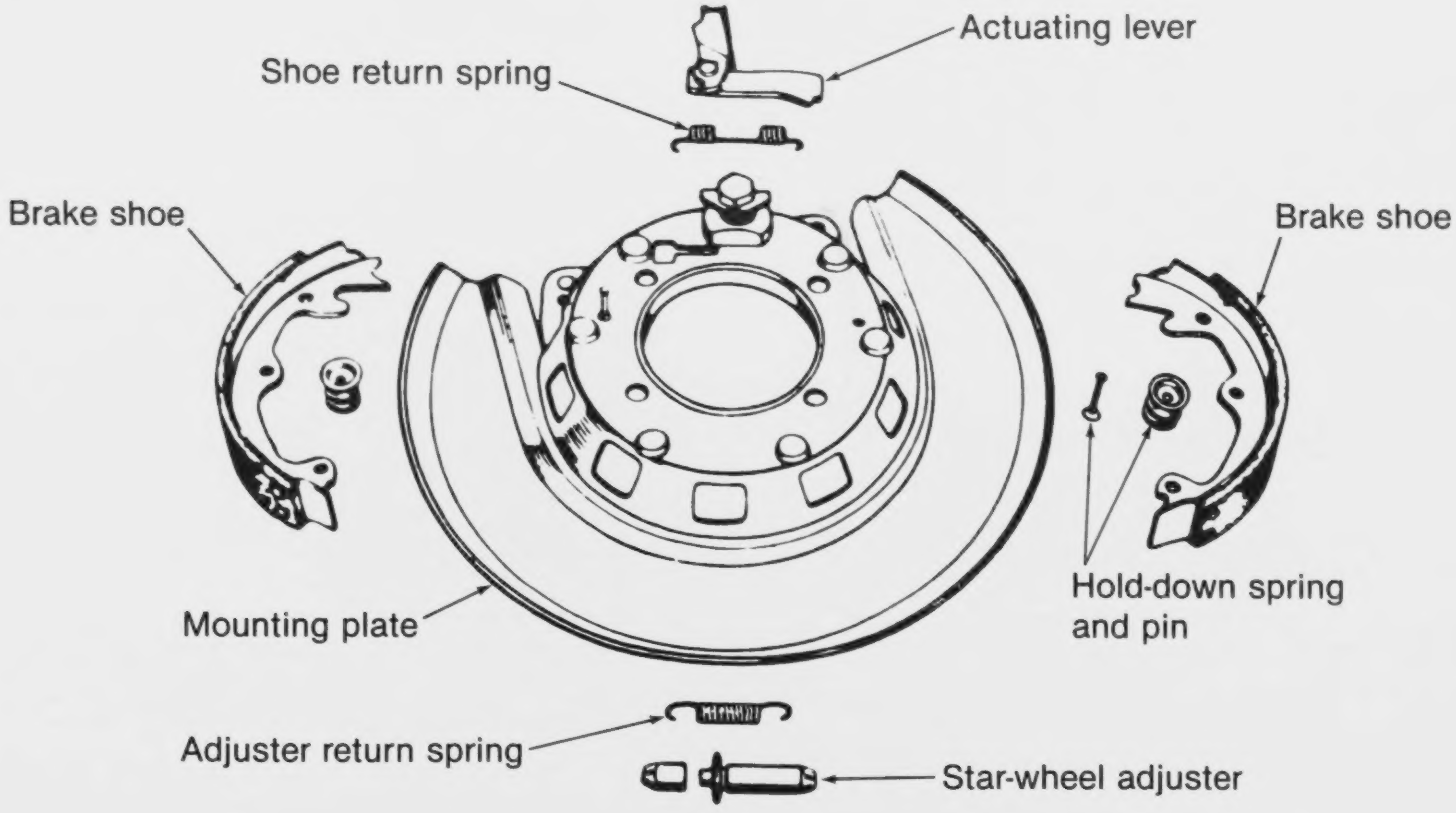
Used with permission of General Motors Corporation, Chevrolet Motor Division.

Parts of a Sliding Caliper Disc Brake Assembly


Caliper housing
Anchor plate
Dust boot
Piston
Seal
Inner shoe and lining
Outer shoe and lining
Key retaining screw
Antirattle spring
Caliper support key
Caliper support spring

Used with permission of Allied Aftermarket.

Auxiliary Drum Parking Brake Assembly


Actuating lever
Shoe return spring
Brake shoe
Brake shoe
Mounting plate
Hold-down spring and pin
Adjuster return spring
Star-wheel adjuster

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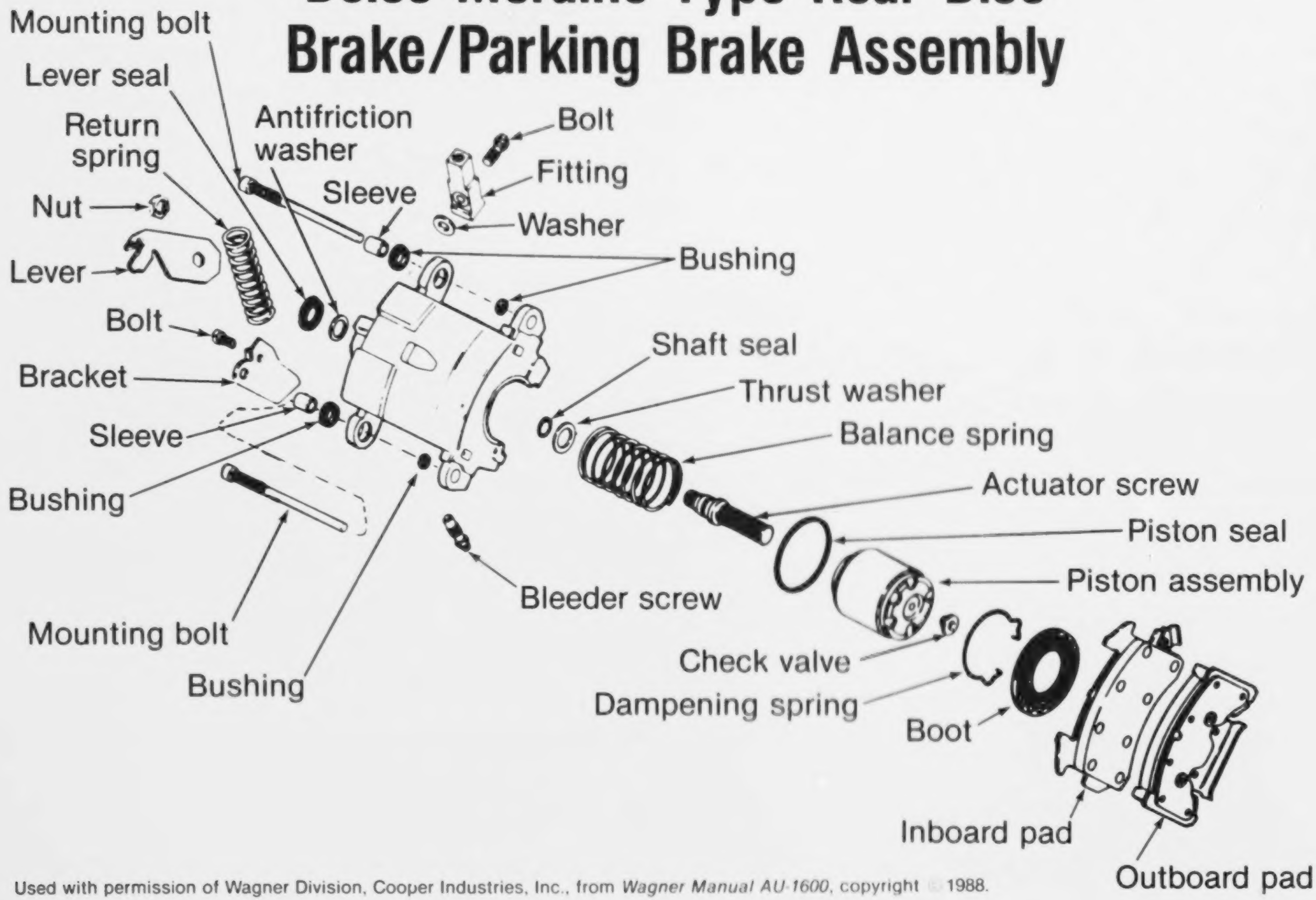
Delco-Moraine-Type Rear Disc Brake/Parking Brake Assembly


Mounting bolt
Lever seal
Return spring
Antifriction washer
Bolt
Fitting
Sleeve
Washer
Nut
Lever
Bushing
Bolt
Bracket
Shaft seal
Thrust washer
Sleeve
Balance spring
Bushing
Actuator screw
Piston seal
Piston assembly
Bleeder screw
Mounting bolt
Check valve
Bushing
Dampening spring
Boot
Inboard pad
Outboard pad

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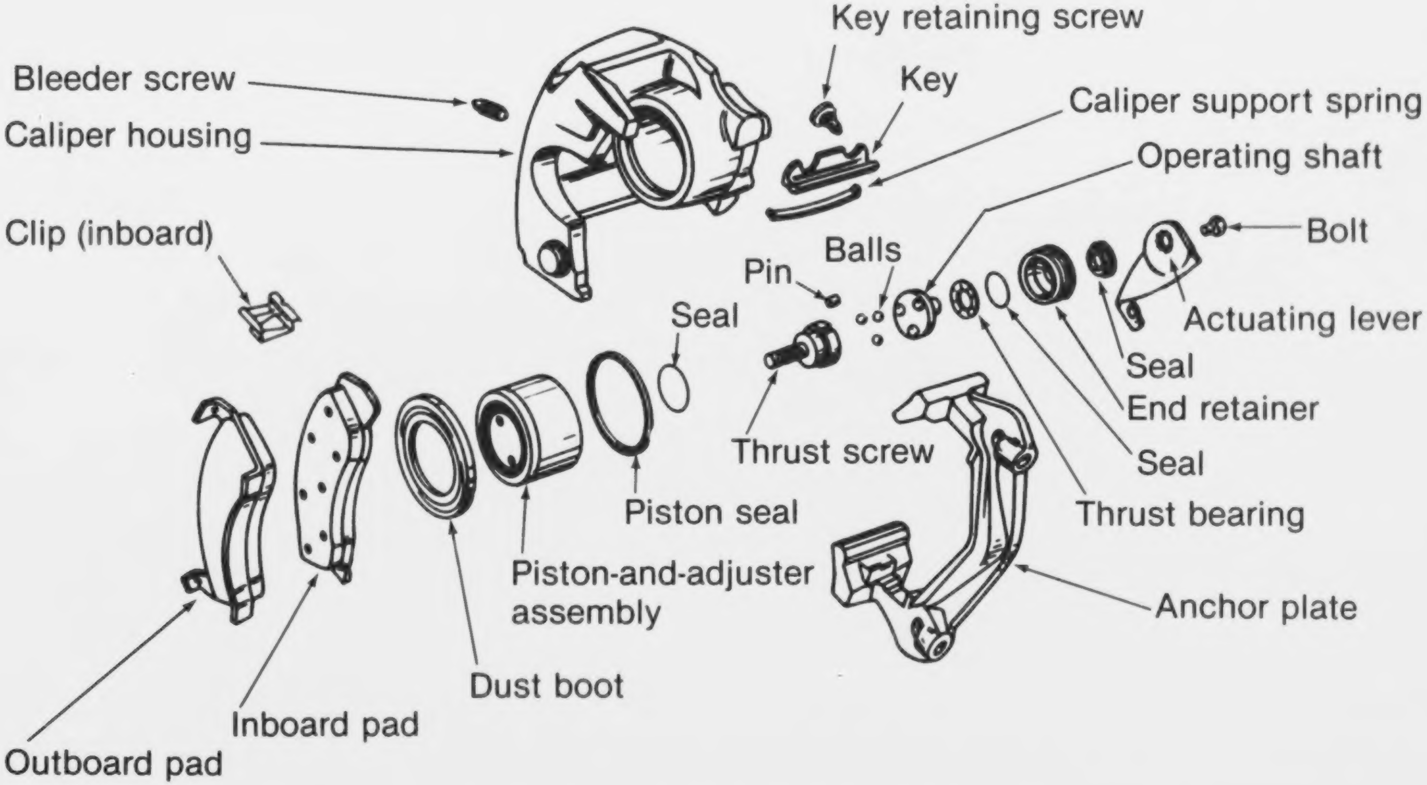
Kelsey-Hayes-Type Rear Disc Brake/Parking Brake Assembly



Key retaining screw
Bleeder screw
Key
Caliper support spring
Caliper housing
Operating shaft
Bolt
Clip (inboard)
Balls
Pin
Seal
Actuating lever
Seal
End retainer
Thrust screw
Seal
Piston seal
Thrust bearing
Piston-and-adjuster assembly
Anchor plate
Dust boot
Inboard pad
Outboard pad

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PRETEST ANSWERS

SERVICE DISC BRAKES

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from the pretest results, use the following table, which shows the correlation between the objectives and written pretest questions. Then counsel students individually on pretest results and study requirements.

TABLE

Correlation between objectives and written pretest questions

Objective	Question
1	3, 8, 17
2	18, 24
3	1, 19
4	4, 9, 21
5	10
6	22
7	2, 5
8	6, 11, 15
9	7, 12
10	13
11	16
12	23
13	20
14	25
15	14

ANSWER KEY

1. c
2. b
3. d
4. a
5. a
6. c
7. b
8. c
9. b
10. c
11. c
12. c
13. d
14. a
15. d
16. a
17. b
18. d
19. a
20. d
21. a
22. d
23. b
24. a
25. d

PRETEST

SERVICE DISC BRAKES

Name ______________________ Score ____________

DIRECTIONS

Read the following questions and problems. Then circle the letter before the item that best answers the question or solves the problem.

1. One of the steps of disc brake operation is "fluid in the primary cylinder is pressurized to apply the front (disc) brakes." What is the next step in disc brake operation?

   a. Pushrod forces primary piston in master cylinder forward
   b. Brake pedal is depressed
   c. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models
   d. None of the above

2. Which of the following is **not** a guideline to follow when removing and reinstalling front disc brake calipers and shoe pads?

   a. Keep grease, oil, and brake fluid off caliper, rotor, and pad-and-lining assemblies
   b. Make sure that both calipers are removed before installing new pads
   c. Make sure that caliper bleed screws can be opened
   d. Do **not** press brake pedal when pads are out or caliper is off rotor

3. Which of the following is the best definition for *disc brake*?

   a. Brake design in which disc-shaped pads are pressed against a metal surface to produce braking action
   b. Brake design in which pressure is exerted inside a drum to slow or stop the vehicle
   c. Brake design in which a cable or linkage assembly is operated to keep the vehicle in place when parked
   d. Brake design in which brake pads contract against a round, flat braking surface to produce braking action

4. Which of the following types of disc brake calipers is mounted on machined ways that allow it to move from side to side in a caliper adapter?

   a. Sliding
   b. Floating
   c. Fixed
   d. None of the above

5. Replace pads when lining is worn ____________ above metal backing plate or ____________ over rivets.

   a. 1/8 inch; 1/16 inch
   b. 1/4 inch; 1/2 inch
   c. 1/16 inch; 1/4 inch
   d. None of the above

6. When reconditioning a multiple-piston disc brake caliper, remove pistons from caliper with

   a. Compressed air
   b. Vise-grip pliers
   c. Caliper piston puller
   d. Cylinder wrench

7. Which of the following would be used to measure a rotor for lateral runout?

   a. Vacuum gauge
   b. Dial indicator
   c. Micrometer
   d. Foot-pound or inch-pound torque wrench

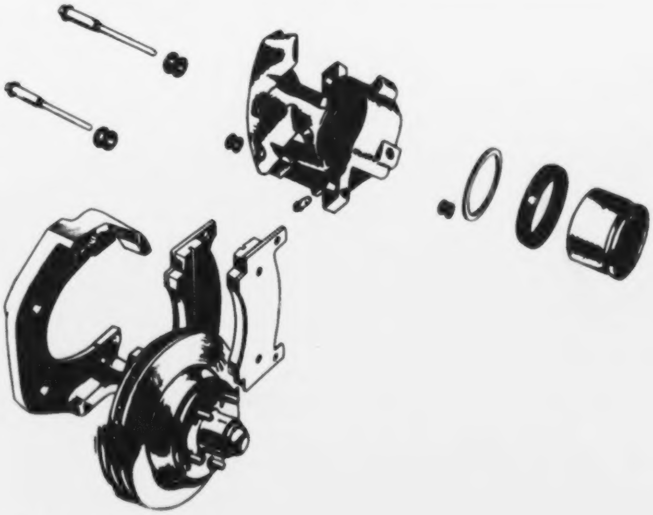
8. The thin bridge between the two disc surfaces of a ventilated disc brake rotor is called

   a. A pad wear indicator
   b. An anchor plate
   c. A vane
   d. An antirattle clip

9. Which of the following types of disc brake calipers usually has four pistons, two on each side of rotor?

   a. Floating
   b. Fixed
   c. Sliding
   d. None of the above

10. Which component in the illustration of a caliper assembly below is **not** in the correct position?



   a. Bleeder screw
   b. Mounting bolts
   c. Caliper
   d. Piston

11. When reconditioning disc brake calipers, which of the following is correct?

   a. Recondition both calipers, then install and bleed both calipers
   b. Replace pistons if black stains are present
   c. Recondition, install, and bleed one caliper before starting work on another
   d. No special considerations or safety measures are necessary when using compressed air to remove pistons

12. To check rotor parallelism, the brakes specialist uses a

    a. Straightedge
    b. Special service tool
    c. Micrometer
    d. Dial indicator

13. When resurfacing a rotor, which of the guidelines below should be observed?

    a. Always resurface both rotors; even if only one rotor needs resurfacing
    b. Always consult manufacturer's instructions for amount to be cut from the friction surface at one time
    c. Do **not** handle the rotor with greasy hands or otherwise contaminate the friction surface of rotor after resurfacing
    d. All of the above

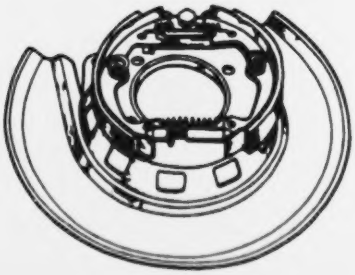
14. Which of the following is the proper corrective action for excessive pedal effort caused by faded or overheated condition, glazed pads, or blued or heat-checked rotors?

    a. Remachine rotor
    b. Check rotor with micrometer and install new rotor if specifications exceed maximum allowed
    c. Free-up pistons and install new spring
    d. Readjust bearings to specified torque

15. Although some calipers will fit either side of a vehicle, they should **not** be interchanged because the

    a. Shoes must be reversed
    b. Dust boots may not seal properly
    c. Pistons move in opposite directions
    d. Bleeder valve will be in the wrong position

16. Why type of parking brake is illustrated below?



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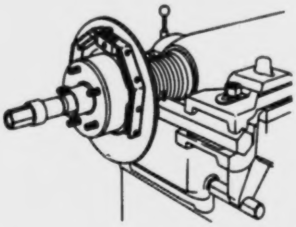
- a. Rear disc/drum (auxiliary drum)
- b. Kelsey-Hayes (Ford) sliding caliper
- c. GM Delco-Moraine
- d. None of the above

17. Which of the following is the best definition for *scoring*?

- a. Light abrasive damage from multiple scratches
- b. Wear damage from multiple scratches
- c. Heat-raised areas on surface
- d. Thin, discolored areas on surface

18. The rotor silencing tool illustrated below is used



Used with permission of AMMCO TOOLS, Inc.

- a. When a nonventilated rotor is machined on both sides at one time
- b. With a ventilated rotor
- c. Both a and b
- d. When rotor is machined on one side at a time

19. In disc brake operation, which of the following would occur immediately after the brake pedal is depressed?

a. Pushrod forces primary piston in master cylinder forward
b. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models
c. Piston(s) in caliper forces brake shoe against rotor, thus slowing wheel rotation
d. Fluid in primary cylinder is pressurized to apply front (disc) brakes

20. In a Kelsey-Hayes-type rear disc parking brake, ____________ force a thrust screw outward, activating the caliper piston and engaging the parking brake.

a. Retracting springs
b. Star wheels
c. Rotation of high lead screws
d. Three balls

21. Which of the following caliper types is bolted to the steering knuckle?

a. Fixed
b. Sliding
c. Floating
d. Rotating

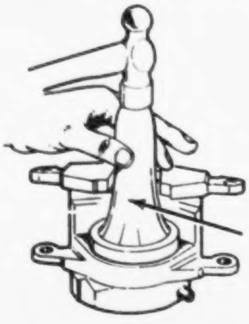
22. Which of the following is **not** an advantage of disc brakes over conventional drum brakes?

a. Provide more straight-line stops
b. Are resistant to water fade
c. Are resistant to heat fade
d. Are resistant to freeze up

23. Which of the following statements about the rear disc/drum (auxiliary drum) parking brake is correct?

a. The shoe-to-drum clearance is adjusted automatically
b. The inner surface of the rotor serves as a drum and is fitted with a small pair of drum-type shoes
c. The design is similar to the rear drum brake parking brake
d. All of the above

24. In the illustration below, the arrow is pointing to a special tool used by the brakes specialist. What is the name of this tool?



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- a. Dust boot installing tool
- b. Bearing race remover
- c. Seal driver
- d. Piston remover

25. The Delco-Moraine-type rear disc parking brake

- a. Should be lubricated during caliper piston service
- b. Should be rotated to opposite side of the vehicle when servicing the disc brakes
- c. Should not be manually adjusted
- d. Should be disassembled and adjusted during pad replacement

500

INFORMATION SHEET

SERVICE DISC BRAKES

OBJECTIVE 1

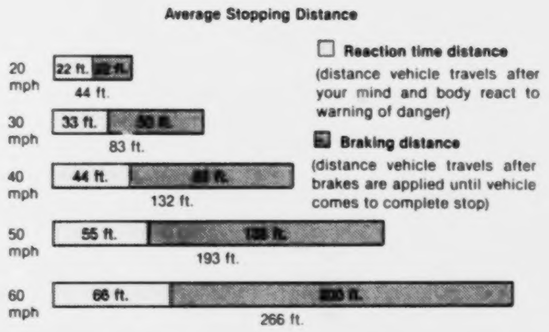
Recognize definitions of terms associated with disc brakes

Disc brake — Brake design in which brake pads contract against a round, flat braking surface to produce braking action

Friction — Resistance to relative motion between two bodies in contact

Friction for Stopping

When brakes are applied on a vehicle, the brake shoes are forced into contact with rotor and/or drum to provide friction that slows the rotation of the wheel. Then, the friction between the tires and the road surface slows the speed of the vehicle. The average stopping distance travelled before the vehicle comes to a full stop is directly related to vehicle speed as shown on the chart below.



Inboard shoe — Shoe on vehicle-frame side of brake disc

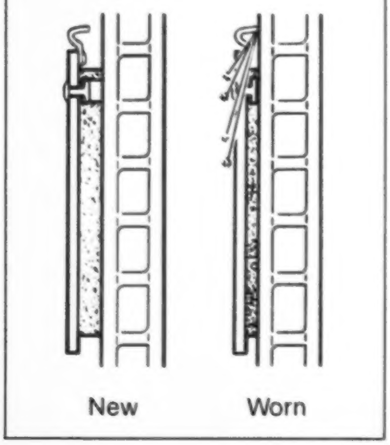
Outboard shoe — Shoe on wheel-cover side of brake disc

Pad wear indicator — Thin, metal tab bent so that it contacts rotor and squeals when lining wears to point where it needs to be replaced (See Figure 1)

NOTE: Another indicator system uses electrical contacts in the pads that touch the rotor when the pads are worn out. This completes a circuit and turns on a dashboard warning light. This system is found on Chrysler, Ford, and other domestic vehicles, and on imports such as Toyotas and Mercedes-Benz.

EXAMPLE:

FIGURE 1



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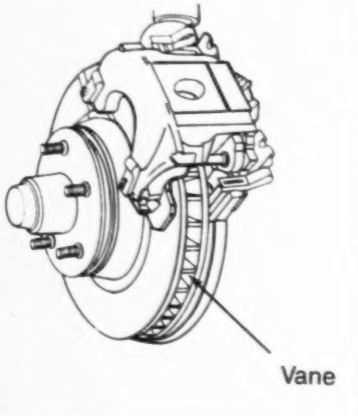
Scoring — Wear damage from multiple scratches

Scuffing — Light abrasive damage spread over a large area

Vane — Thin bridge between the two disc surfaces of a ventilated disc brake rotor (Figure 2)

EXAMPLE:

FIGURE 2



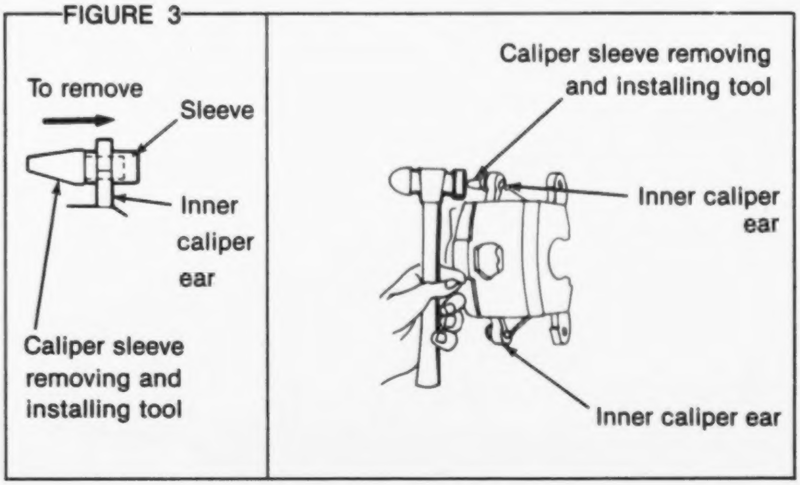
Used with permission of Allied Aftermarket.

OBJECTIVE 2

Recall specialty tools used to service disc brakes

- Caliper sleeve removing and installing tool (Figure 3)

FIGURE 3


To remove
Sleeve
Inner caliper ear
Caliper sleeve removing and installing tool
Caliper sleeve removing and installing tool
Inner caliper ear
Inner caliper ear

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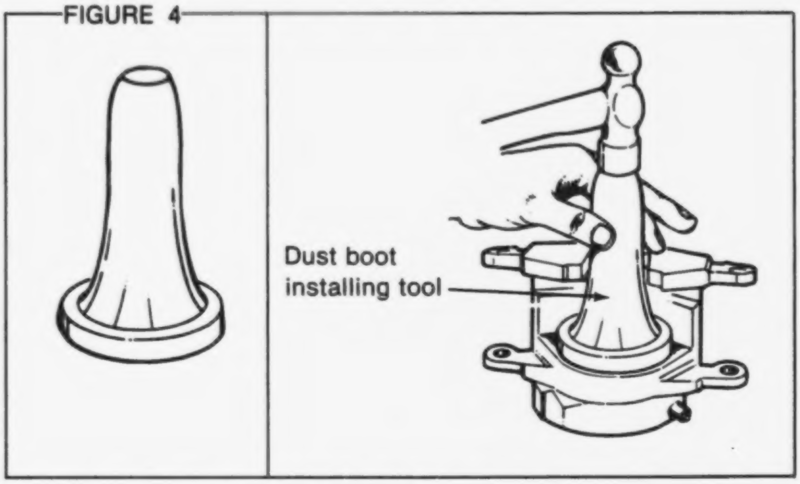
- Dust boot installing tool (Figure 4)

FIGURE 4


Dust boot installing tool

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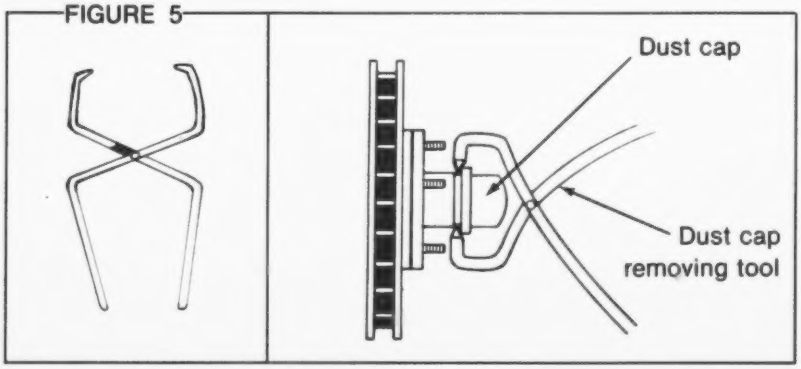
- Dust cap removing tool (Figure 5)

NOTE: The "dust cap" is also called a *grease cap* or *dust cover*. When a dust cap removing tool is not available, the cap may be removed with channel-lock pliers.

FIGURE 5



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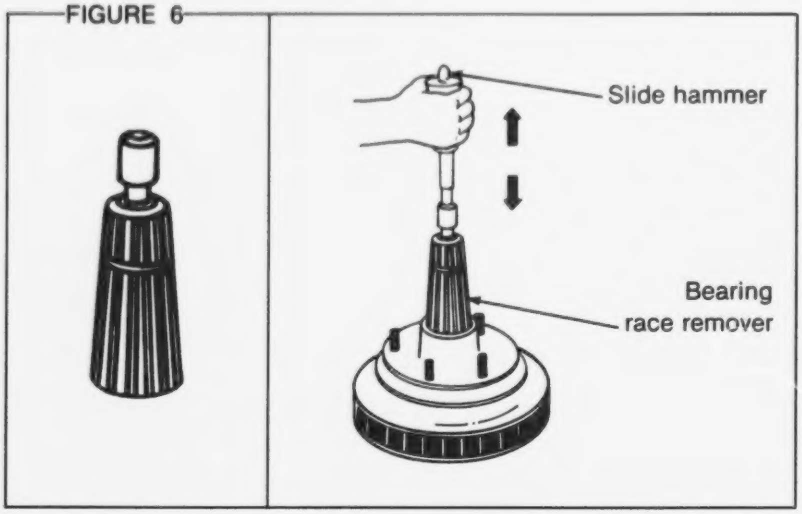
- Bearing race remover (Figure 6)

FIGURE 6



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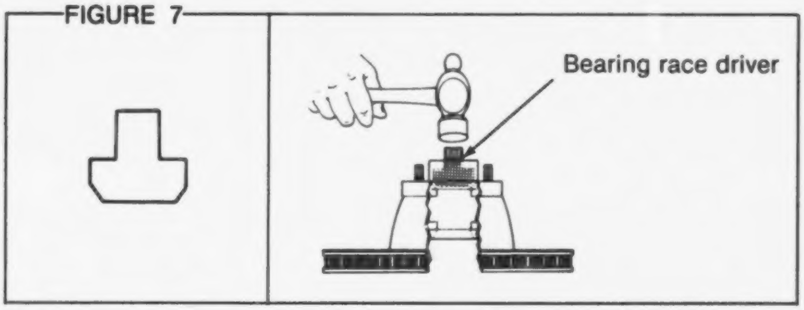
- Bearing race driver (Figure 7)

FIGURE 7



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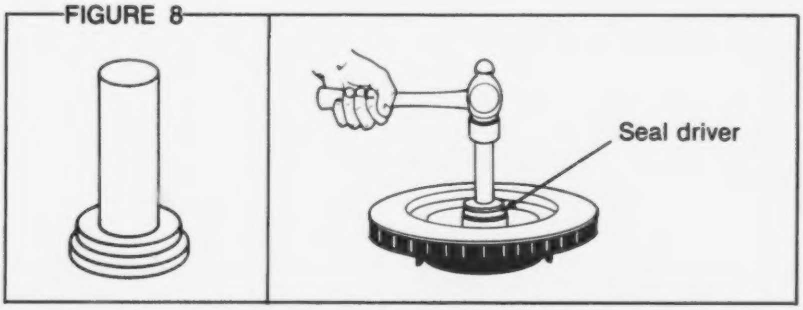
- Seal driver (Figure 8)

FIGURE 8



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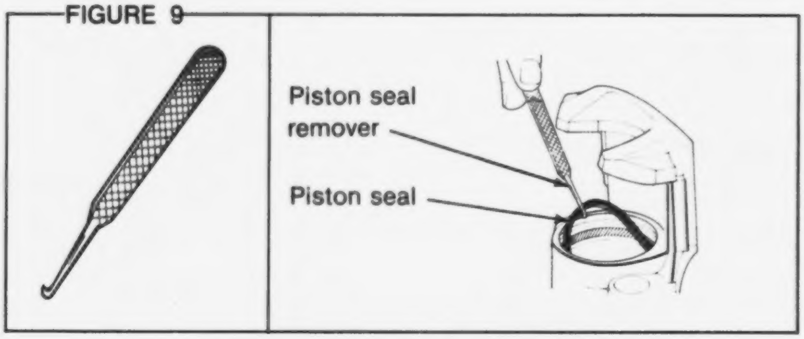
- Piston seal remover (Figure 9)

FIGURE 9



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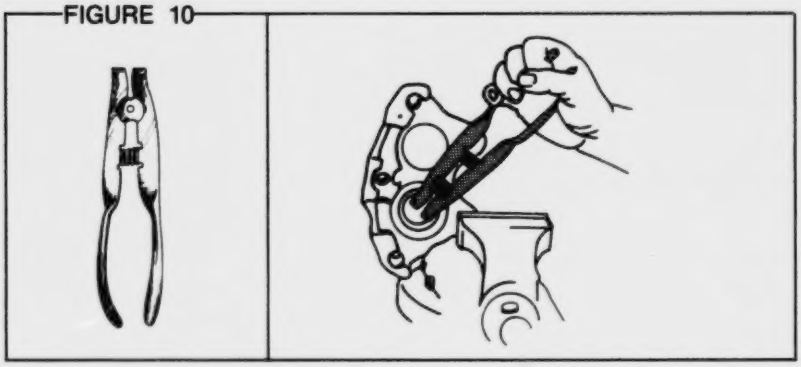
- Piston remover (Figure 10)

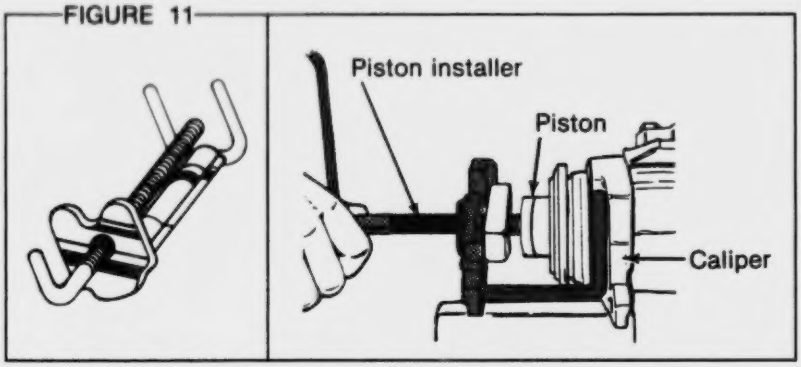
FIGURE 10



Adapted with permission of Raybestos/Brake Systems, Inc.

- Piston installer (Figure 11)

FIGURE 11



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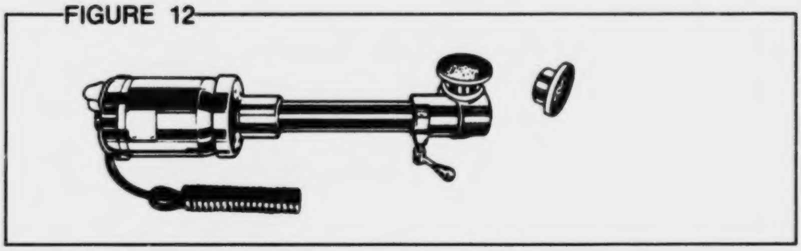
- Disc rotor grinder (Figure 12)

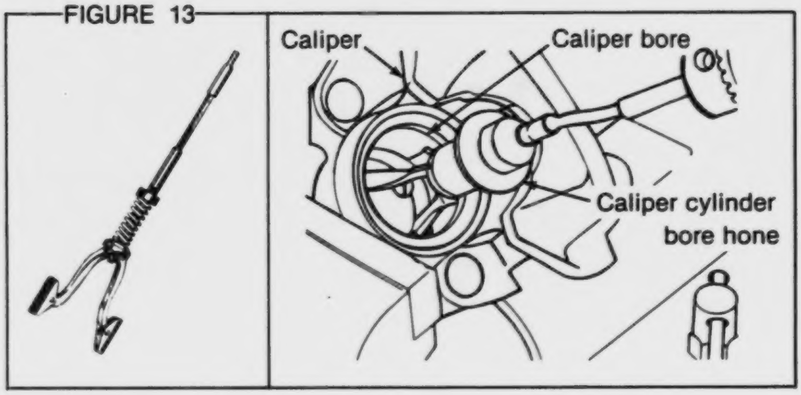
FIGURE 12



Used with permission of AMMCO TOOLS, Inc.

- Caliper cylinder bore hone (Figure 13)

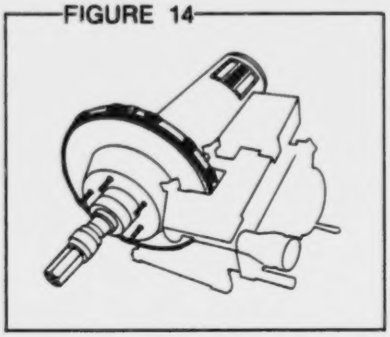
FIGURE 13


Caliper
Caliper bore
Caliper cylinder bore hone

Used with permission of Chrysler Corporation.

- Rotor silencing band for use with ventilated rotor (Figure 14)

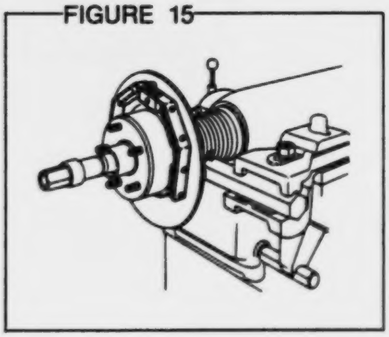
FIGURE 14



Used with permission of AMMCO TOOLS, Inc.

- Rotor silencer for use when rotor is machined on one side at a time (Figure 15)

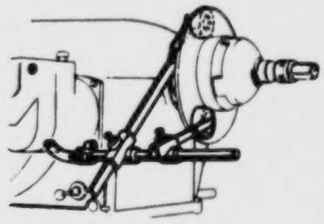
FIGURE 15



Used with permission of AMMCO TOOLS, Inc.

- Rotor silencer for use on nonventilated rotors (Figure 16)

FIGURE 16



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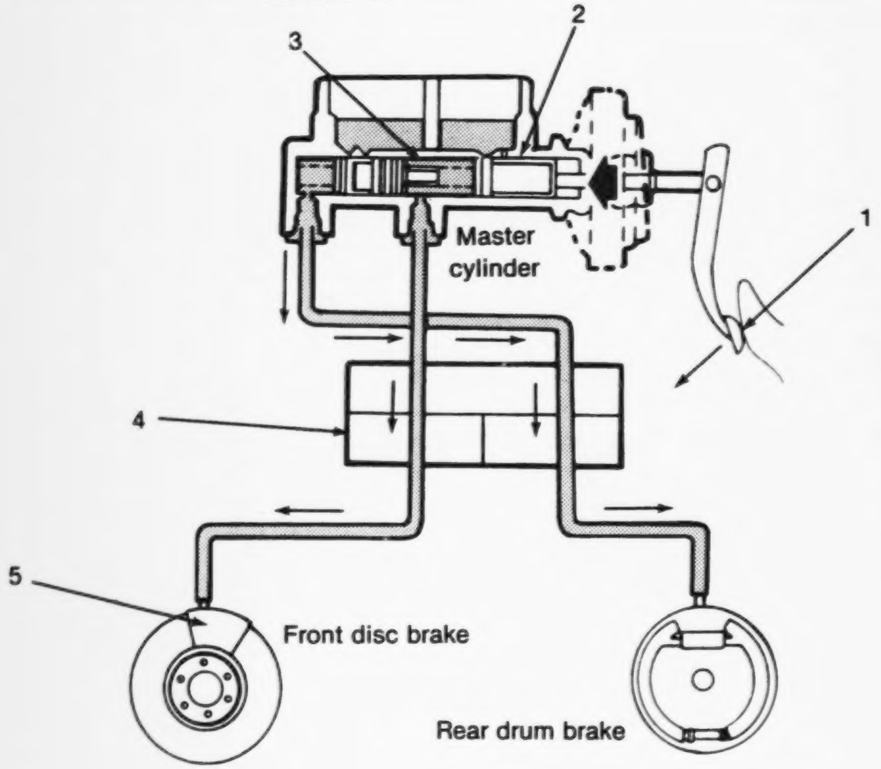
OBJECTIVE 3

Recall the steps of disc brake operation

1. Brake pedal is depressed
2. Pushrod forces primary piston in master cylinder forward
3. Fluid in primary cylinder is pressurized to apply front (disc) brakes
4. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models
5. Piston(s) in caliper forces brake shoe against rotor, thus slowing wheel rotation

FIGURE 17



Used with permission of Ford Motor Company.

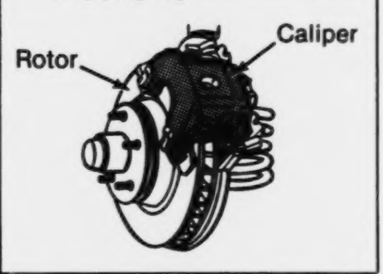
OBJECTIVE 4

Recall descriptions of types of disc brake calipers

Floating caliper — Is mounted on bolts through rubber bushings that permit it to move; has one large piston, and the braking force is exerted against caliper adapter (Figure 18)

EXAMPLE:

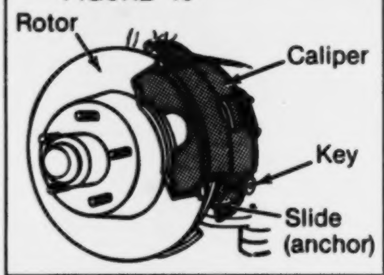
FIGURE 18



Sliding caliper — Is mounted on machined ways that allow it to move from side to side in caliper adapter, which also receives braking force; has one or two pistons (Figure 19)

EXAMPLE:

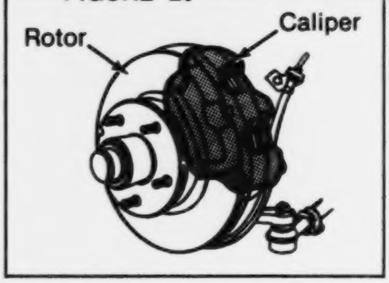
FIGURE 19



Fixed caliper — Is rigidly bolted directly to steering knuckle; usually has four pistons, two on each side of rotor (Figure 20)

EXAMPLE:

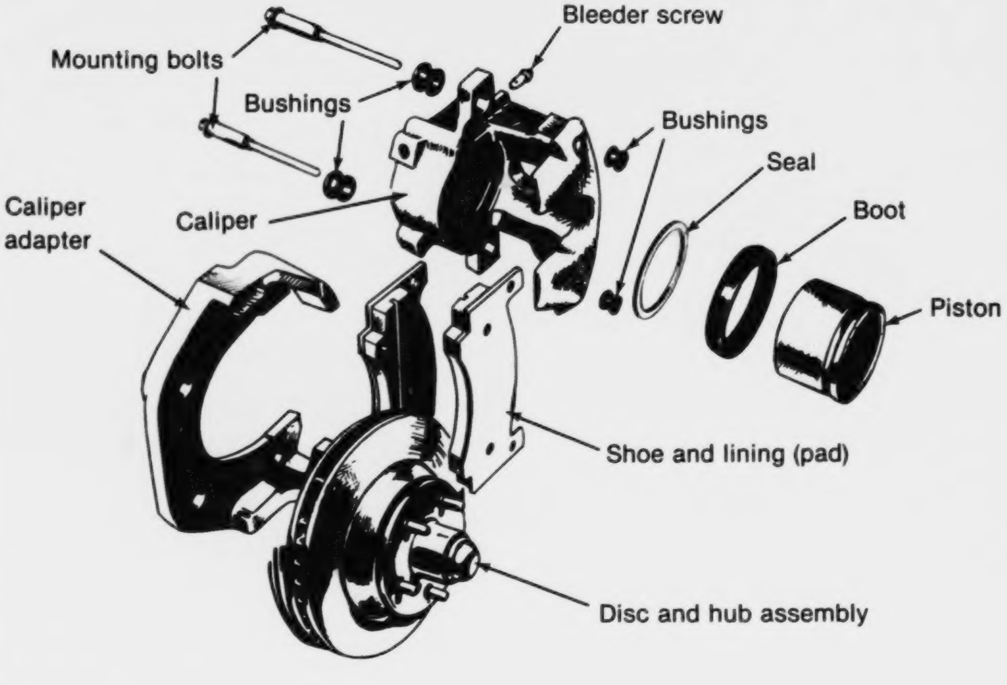
FIGURE 20



Figures 18-20 used with permission of Allied Aftermarket.

OBJECTIVE 5 | Recall the parts of a typical floating caliper assembly

FIGURE 21


Bleeder screw
Mounting bolts
Bushings
Bushings
Seal
Caliper adapter
Caliper
Boot
Piston
Shoe and lining (pad)
Disc and hub assembly

Gypsy Brake Pads

The material of which brake pads are made must pass tests that measure, among other things, its ability to grip as it should when the brakes get hot. Brake pads made by large, name-brand manufacturers will show some markings stamped into the edges of the friction materials. But brake pads sold by so-called "gypsy" parts distributors usually do not carry these markings. Since they need not be tested, gypsy parts may not meet even the low standards set for friction materials by the Vehicle Equipment Safety Commission, which is funded by congress.

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OBJECTIVE 6

Recall the advantages of disc brake design

- Are resistant to heat fade
- Are resistant to water fade
- Provide more straight-line stops
- Adjust automatically and can be equipped with a pad wear indicator
- Are easier to service than drum brakes

Disc Brake Design Features

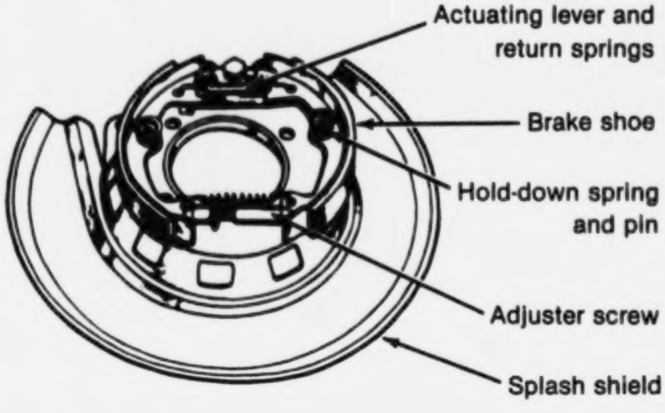
While working with disc brakes, you will realize that the design of disc brakes offers certain advantages. For example, the design of the disc brake rotor exposes more surface to the air than that of drum brakes, and thus dissipates heat more efficiently. Also, the rotation of the rotor throws off moisture, thus disc brakes are affected very little by water fade. Disc brakes are less apt to pull than are drum brakes, due to their clamping action, thus producing more straight-line stops. They automatically adjust as pads wear, and some designs are equipped with a device that squeals when the pads need replacement. Disc brakes are of a simpler design than drum brakes, and there are fewer types of designs and fewer movable parts than for drum brakes.

OBJECTIVE 11

Recognize types of parking brakes used on vehicles with rear disc brakes

Rear disc/drum (auxiliary drum) — Cable-operated parking brake with small 6 ½-inch diameter servo-type brake with star-wheel adjuster; located within rotor hub, independent of regular brake (Figure 22)

FIGURE 22


Actuating lever and return springs
Brake shoe
Hold-down spring and pin
Adjuster screw
Splash shield

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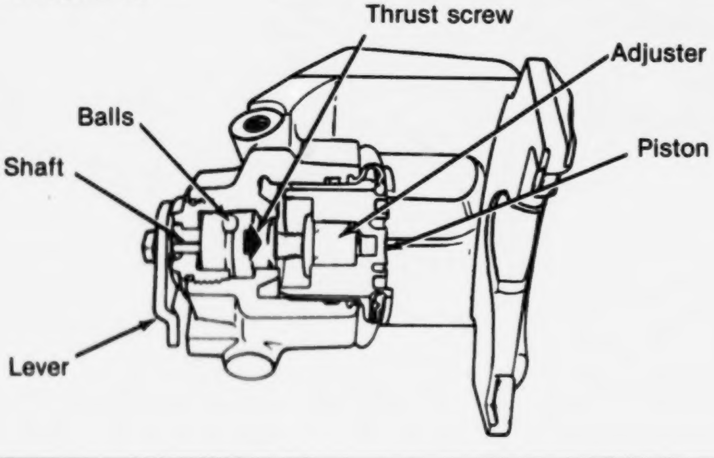
Kelsey-Hayes (Ford) sliding caliper — Mechanically operated lever works ball-and-ramp device within parking brake to force pads against rotor; integral part of regular brake (Figure 23)

FIGURE 23


Thrust screw
Adjuster
Balls
Shaft
Piston
Lever

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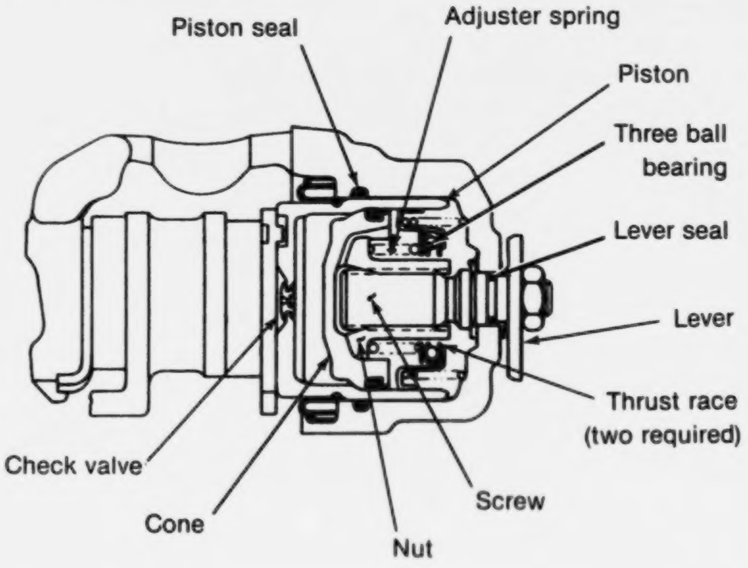
GM Delco-Moraine — Mechanically operated lever connected to a high lead screw—which is passed through a nut in the piston—moves piston along screw to engage brake; integral part of regular brake (Figure 24)

FIGURE 24


Piston seal
Adjuster spring
Piston
Three ball bearing
Lever seal
Lever
Thrust race (two required)
Check valve
Cone
Nut
Screw

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STUDENT SUPPLEMENTS

SERVICE DISC BRAKES

SUPPLEMENT 1

Troubleshooting Chart for Disc Brakes

NOTE: This chart covers conditions that may be caused by disc brake problems. However, some of these conditions may result from other malfunctions, such as wheel bearing defects or problems in the suspension or steering systems. This chart is intended to help you diagnose suspected disc brake problems. Other procedures may be required if the problem is elsewhere.

Condition	Possible cause	Corrective action
Depressing brake pedal produces no braking effect	Reservoir fluid level low	Check for cause of fluid leak, repair as required, refill the reservoir
	Air in the hydraulic system	Bleed system
	Bleeder screw open	Close bleeder screw and bleed system
	Improperly positioned pads (while servicing the calipers, pistons may have been pushed back in cylinder bores)	Reposition pads (depress pedal a second time)
	Misadjusted rear brakes	Adjust properly
	Leak in rear brake cylinder	Hone cylinder bore; replace piston seals or replace caliper
	Piston seal damaged in one or more of the cylinders	Disassemble caliper and replace piston seals
	Leak past piston cups in master cylinder	Recondition or replace master cylinder

Condition	Possible cause	Corrective action
Excessive pedal effort	Pads worn below minimum thickness	Install new pads
	Master cylinder or power brake malfunction	Check and correct affected parts
	"Faded" overheated condition, glazed pads, "blued" or heat-checked rotors	Remachine rotor
	Grease, oil, brake fluid on pads	Install new pads
	Seized or frozen pistons	Disassemble caliper and free up pistons
Excessive pedal travel	Air in the system	Bleed system; replenish the fluid
	Insufficient or improper brake fluid (boil)	Drain, flush, and refill with correct fluid
	Master cylinder not functioning properly	Check and repair affected parts
	Excessive rotor runout	Check rotor with dial indicator; install new rotor if runout exceeds maximum specified
	Excessively tapered or warped pads	Install new pads
	Damaged caliper piston seal	Install new piston seal
	Rear brakes out of adjustment	Check and adjust as necessary
Pedal pulsation (brake roughness or chatter)	Excessive lateral runout of brake rotor	Check rotor with dial indicator; install new rotor if runout exceeds the maximum specified
	Excessive out-of-parallelism of brake rotor	Check parallelism with micrometer, and remachine rotor or install a new one if parallelism exceeds maximum allowed

Condition	Possible cause	Corrective action
Car pulls to one side	Brake fluid, oil, grease, water, mud, or dirt on linings	Install new pads
	Unmatched linings	Install matched sets of pads
	Seized or frozen pistons	Disassemble caliper and repair
	On rear brakes—misadjustment, sticking pistons or broken spring	Adjust rear brakes, free up the pistons, install new spring
	Distorted disc brake shoes	Install new brake pads
	Restricted hose or line	Examine hoses and lines; replace as necessary
Leaky wheel cylinder	Cylinder bore surface scored or corroded	Disassemble caliper, hone cylinder bore; install new seal
	Caliper piston seal damaged or worn	Disassemble caliper and install new seal
Front brakes heat up during driving and fail to release	Residual check valve in the master cylinder front brake outlet	Remove that valve from master cylinder at front brake line outlet
	Sticking pedal linkage	Free up and lubricate as necessary
	Frozen or seized pistons	Disassemble caliper and free up pistons
	Driver in habit of riding brake pedal	Instruct driver to give up that habit

Condition	Possible cause	Corrective action
Brake noises		
• **Chatter**	Excessive lateral runout of rotor	Check runout with dial indicator; install new disc if the runout exceeds maximum specified
	Lack of rotor parallelism	Check parallelism with micrometer; remachine disc, or install a new one, as required
• **Scraping**	Rust or mud buildup on edges of rotor and on caliper housing	Clean or replace as necessary
	Worn pad; metal tabs or backing exposed to rotor	Replace pad; repair or replace faulty parts
• **Groan or creep-groan**	Releasing brake pedal slower than the spring returns	Slightly increase or decrease pedal effort to eliminate noise
• **Rattle**	Excessive clearance between shoe and caliper	Install new pads
	Shoe antirattle spring missing or not properly positioned (Kelsey-Hayes or Budd types only)	Install new antirattle spring or position properly

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ASSIGNMENT SHEET 1

SERVICE DISC BRAKES

OBJECTIVE 15

Diagnose disc brake problems

Name ______________________________ Score ____________

INTRODUCTION

Brake service is one of the most important and most common services performed in the automotive industry. State vehicle inspections are now required in most states, and an important part of that inspection is brake inspection. Therefore, vehicle owners need to have their vehicles' brakes periodically checked and repaired so their vehicles comply with state inspection standards. The normal wear and tear of everyday driving takes its toll on the vehicle's braking system. This means that the brakes specialist must be able to analyze customer complaints, inspect vehicle brake systems to locate problems, and ultimately diagnose the problems and repair them properly the first time.

DIRECTIONS

Study Student Supplement 1, "Troubleshooting Chart for Disc Brakes," and then read each of the following questions carefully. Select the answer for each that is *most* correct. Write the correct letters in the blanks.

_____1. You have just reconditioned disc brake calipers and are now testing brake function. When you depress the brake pedal, there is no braking effect. Which of the following is the *most likely* cause?

a. Brake fluid, oil, grease, water, mud, or dirt on linings
b. Not enough clearance between shoe and caliper
c. Improperly positioned pads caused by pistons being pushed back in cylinder bores

_____2. The owner of a vehicle complains that sometimes the brake pedal fails to release. You road test the vehicle to verify the complaint and discover that the problem is caused by the front brakes heating up during driving. Which of the following would be the *most likely* cause of this problem?

a. Sticking pedal linkage
b. Reservoir fluid level low
c. Damaged caliper piston seal

______3. You have just determined that the reason a customer's vehicle pulls to one side is that the pistons are seized or frozen. Which of the following would be the proper corrective measure?

a. Disassemble caliper, and repair or replace pistons
b. Bleed caliper
c. Drill 1/4-inch hole in piston to free up

______4. Following up on a customer complaint, you find that the brake pads are worn and the metal tabs are exposed to the rotor. Which of the following was the customer's complaint?

a. Chatter-type noise
b. Scraping sound
c. Deep groan

______5. Which of the following would **not** be a reason for installing new brake pads?

a. Excessive clearance between shoe and caliper
b. Improperly positioned pads
c. Oil-contaminated pads

______6. The owner of a late-model vehicle complains of excessive pedal effort. Which of the following is the *most likely* cause?

a. Excessive lateral runout of brake disc
b. Distorted disc brake shoes
c. Pads worn below minimum thickness

______7. In servicing a vehicle, you determine that the cause of brake pedal pulsation is excessive out-of-parallelism of the brake disc. Which of the following would be the proper corrective measure?

a. Check disc thickness with micrometer and install new disc if variation exceeds maximum allowed
b. Check disc thickness with dial indicator and install new disc if variation exceeds maximum allowed
c. Check disc thickness with micrometer and hone disc or install new disc if variation exceeds maximum allowed

_____8. In following up on a customer complaint, you find that the bleeder screw is open. Which of the following was the customer's complaint?

a. No braking effect when brake pedal is depressed
b. Excessive pedal travel
c. Excessive pedal effort

_____9. The owner of a late-model Toronado equipped with a Kelsey-Hayes-type caliper complains of hearing a rattling sound in the front of the vehicle. Which of the following would be the *most likely* cause?

a. Excessive clearance between antirattle shoe and caliper
b. Faulty caliper alignment permitting rotor to touch housing
c. Shoe antirattle spring missing or not properly positioned

_____10. The owner of a 1985 Caprice complains of hearing a high-pitched squealing during brake application. Which of the following is the *most likely* cause?

a. Lack of clearance between caliper and knuckle
b. Front linings worn out
c. Disc brake shoe reversed (steel against rotor)

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ASSIGNMENT ANSWERS

SERVICE DISC BRAKES

ASSIGNMENT SHEET 1

1. c
2. a
3. a
4. b
5. b
6. c
7. a
8. a
9. c
10. b

ACTIVITY SHEETS

SERVICE DISC BRAKES

ACTIVITY SHEET 1

Answer general questions about disc brakes

Name ____

INTRODUCTION

To become certified as a brakes specialist, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence. The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only disc brakes, but it contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is *most* correct, and write its letter in the answer blank.

After you have completed this activity sheet, get together with a group of your classmates and use the answer key to check your answers. Each correct answer counts 4 points for a total score of 100 percent. Pay particular attention to those questions that you answered incorrectly. Do your incorrect answers indicate an area of weakness? Were these incorrect answers caused by carelessness or lack of knowledge. What steps must you take to improve your percentage of correct answers?

Discuss your answers with your group and with the class as a whole.

_____1. The most common type of disc brake caliper found on American cars today is the

a. Single-piston sliding
b. Two-piston fixed
c. Two-piston sliding
d. Four-piston fixed

_____2. Some cars with front disc brakes use a metering valve. When bleeding this type of brake with a pressure tank, which of the following apply?

a. The metering valve plunger must be pushed to the closed position
b. The metering valve has no effect on bleeding brakes if a diaphragm-type pressure tank is used
c. The metering valve plunger must be held open
d. Both a and b

______3. To check rotor parallelism, you use a

a. Straightedge
b. Micrometer
c. Dial indicator
d. Special service tool

______4. A vehicle equipped with power disc brakes requires excessive pedal effort to stop.

Specialist A says that the brake pads could be worn below minimum thickness.

Specialist B says that the pads could be contaminated with grease, oil, or brake fluid.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

______5. The owner of a vehicle with front disc brakes states that the brake pedal pulsates rapidly when the brakes are applied. Which of the following could cause such a condition?

a. Improperly adjusted wheel bearing
b. Uneven rotor thickness
c. Excessive rotor runout
d. All of the above

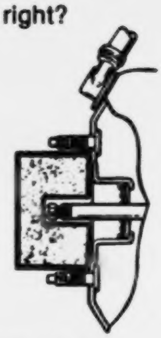
______6. The figure 0.0125 millimeter is a dimension commonly used for maximum

a. Rotor lateral runout
b. Rotor parallelism
c. Rotor radial runout
d. Caliper piston/bore clearance

______7. Specialist A says that if the adjustment below is incorrect, the brakes will drag.

Specialist B says that if the adjustment below is incorrect, excess pedal travel will result.

Who is right?



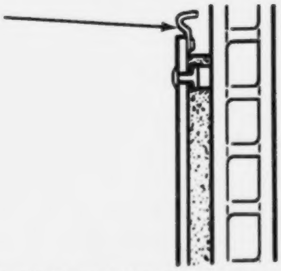
a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 11, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

______8. When checking disc brake rotor lateral runout

a. Use an inside micrometer
b. Use a pair of calipers
c. Use an outside micrometer
d. Use a dial indicator

______9. The arrow in the illustration below is pointing to



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600*, copyright ©1988.

a. An antirattle clip
b. A stabilizer
c. An anchor plate
d. A wear indicator

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_____10. Disc brakes normally use no residual pressure check valve because

a. Disc brakes use a metering valve
b. Residual pressure would delay front brake application
c. Residual pressure would cause dragging brakes
d. Disc brakes use a proportioning valve

_____11. Before replacing disc brake pads, remove some of the brake fluid from the master cylinder reservoir that feeds the disc brakes. This will

a. Prevent fluid overflow when pistons are pushed back into calipers
b. Make bleeding easier
c. Allow pressure to front and rear axles to equalize
d. Prevent the brake warning light from coming on

_____12. The owner of an American passenger car complains of a pull to the right when she steps on the brakes.

Specialist A says that the trouble could be caused by a sticking pedal linkage

Specialist B says that the trouble could be caused by unmatched or contaminated pads.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

_____13. The disc brake portion of the master cylinder is low on fluid.

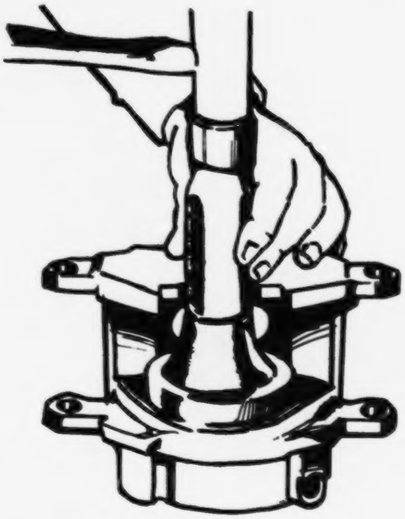
Specialist A says that the brake pads must be worn.

Specialist B says that there must be air in the system.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

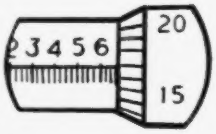
_____14. What operation is the specialist performing in the picture below?



a. Installing a square-cut seal
b. Installing a caliper piston
c. Installing a dust boot
d. None of the above

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 18, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____15. What is the reading on the micrometer below?



a. 0.647
b. 0.683
c. 0.698
d. None of the above

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed., ©1983, p. 20, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

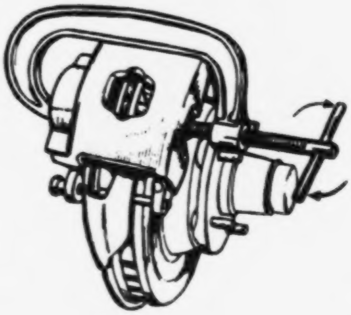
_____16. On a vehicle with front disc brakes, violent cornering on rough roads may cause

a. A drop in fluid pressure
b. Excessive pedal travel
c. Both a and b
d. Neither a nor b

_____17. On a slick road, what prevents the front disc brakes from locking up at light pedal pressures before the drum brakes develop sufficient stopping force?

a. Metering valve
b. Proportioning valve
c. Bypass valve
d. Residual valve

_____18. The illustration below shows the



a. Caliper piston being pushed into its bore
b. Caliper mounting pin being pressed out
c. Outboard shoe being attached to caliper
d. Shoes being seated

J. G. Hughes, *Guide to the Automobile Certification Examination*, rev. ed. ©1983, p. 23, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

_____19. The advantages of sliding caliper disc brakes are

a. There are no advantages; it is simply manufacturer's choice
b. They are heavier than other calipers and will dissipate heat faster
c. They will compensate for slight disc warp because the actuating cylinders are on one side of caliper only
d. They permit the use of a much heavier disc

______20. An antomobile has single-piston floating caliper disc brakes. The right front (RF) pad between the caliper piston and rotor is badly worn. The other RF pad shows barely any wear.

Specialist A says that too much rotor runout could be the cause.

Specialist B says that a stuck caliper piston could be the cause.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

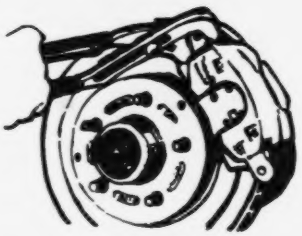
______21. Specialist A says that using an impact wrench to tighten wheel stud nuts can distort the rotor.

Specialist B says that a star-pattern tightening sequence should be used when tightening wheel stud nuts.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

______22. What is the brakes specialist doing in the picture below?



a. Removing the outer shoe retaining clips
b. Crimping the outer shoe ears
c. Locating the positioners
d. None of the above

J. G. Hughes, ***Guide to the Automobile Certification Examination***, rev. ed. ©1983, p. 37, (A Reston Publication). Adapted with permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

______23. Specialist A says to replace guide pins when rebuilding a caliper.

Specialist B says to replace the pushrod when rebuilding a caliper.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

______24. A rotor has excessive thickness variation (lack of parallelism). Which of the following would this condition *most likely* cause?

a. Low brake pedal
b. Nervous pulsating brake pedal
c. Wheel lockup
d. Air to enter the hydraulic system

______25. An automobile with floating caliper disc brakes pulls to the right.

Specialist A says that this could be caused by a frozen caliper piston.

Specialist B says that this could be caused by incorrect tire pressure.

Who is right?

a. Specialist A
b. Specialist B
c. Both A and B
d. Neither A nor B

ACTIVITY SHEETS

SERVICE DISC BRAKES

ACTIVITY SHEET 2

Interpret service manual diagnostic charts

Name ____

INTRODUCTION

Most service manuals contain brake diagnostic charts that refer the specialist to other tables or charts for specific makes and models of vehicles. These charts are more specific than those found in training manuals and textbooks and provide greater detail than the general textbook-type charts. Often these service manual charts indicate not only the problem and corrective actions needed, but also outline a troubleshooting sequence or procedure.

DIRECTIONS

Study the following service manual charts carefully, and then refer to the appropriate chart to answer the questions that follow.

BASIC DIAGNOSIS GUIDE

SYMPTOM	CHART 1 MISC. COND.	CHART 2 ACTUATION	CHART 3 POWER BRAKES	CHART 4 BRAKE NOISE	CHART 5 WHEEL BRAKES
BRAKE WARNING LIGHT "ON"		X	NO		
EXCESSIVE PEDAL TRAVEL		X	NO		0
PEDAL GOES TO FLOOR	60	X			
STOP LIGHT "ON" WITHOUT BRAKES	3X				
ALL BRAKES DRAG	5X	0			
REAR BRAKES DRAG	2X	NO	NO		
GRABBY BRAKES			0		X
SPONGY BRAKE PEDAL		X	NO		
PREMATURE REAR LOCKUP	40	NO	NO		0
EXCESSIVE PEDAL EFFORT	1X		0		
ROUGH ENGINE IDLE			0		
BRAKE CHATTER (ROUGH)		NO	NO		X
SURGE DURING BRAKING					X
NOISE DURING BRAKING				X	
RATTLE OR CLUNKING NOISE		NO		X	
PEDAL PULSATES DURING BRAKING		NO	NO		X
PULL TO RIGHT OR LEFT		NO	NO		X

NO: NOT POSSIBLE CAUSE X: MOST LIKELY CAUSE 0: POSSIBLE CAUSE

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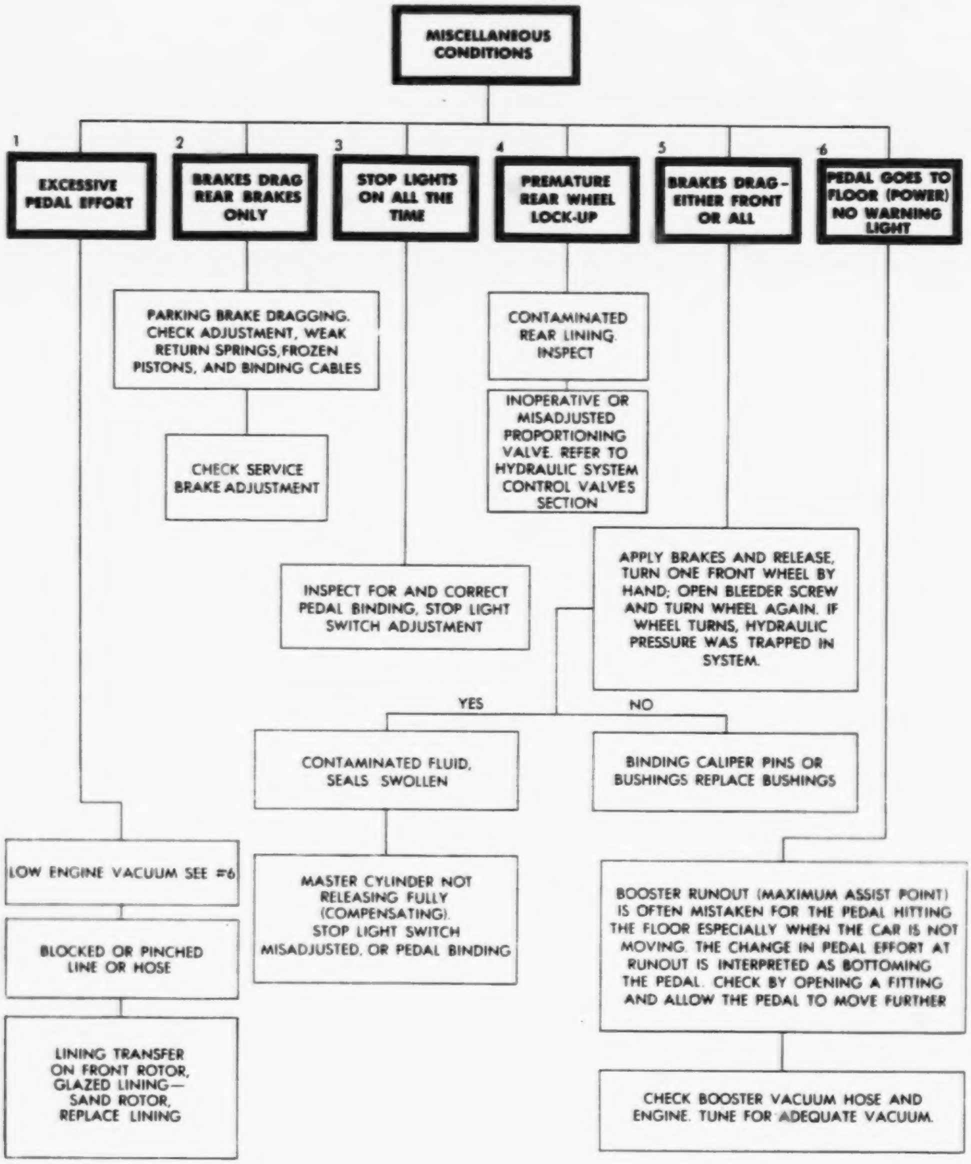
CHART 1



MISCELLANEOUS CONDITIONS

1 **EXCESSIVE PEDAL EFFORT**

LOW ENGINE VACUUM SEE #6

BLOCKED OR PINCHED LINE OR HOSE

LINING TRANSFER ON FRONT ROTOR, GLAZED LINING—SAND ROTOR, REPLACE LINING

2 **BRAKES DRAG REAR BRAKES ONLY**

PARKING BRAKE DRAGGING. CHECK ADJUSTMENT, WEAK RETURN SPRINGS, FROZEN PISTONS, AND BINDING CABLES

CHECK SERVICE BRAKE ADJUSTMENT

3 **STOP LIGHTS ON ALL THE TIME**

INSPECT FOR AND CORRECT PEDAL BINDING, STOP LIGHT SWITCH ADJUSTMENT

4 **PREMATURE REAR WHEEL LOCK-UP**

CONTAMINATED REAR LINING. INSPECT

INOPERATIVE OR MISADJUSTED PROPORTIONING VALVE. REFER TO HYDRAULIC SYSTEM CONTROL VALVES SECTION

5 **BRAKES DRAG - EITHER FRONT OR ALL**

APPLY BRAKES AND RELEASE, TURN ONE FRONT WHEEL BY HAND; OPEN BLEEDER SCREW AND TURN WHEEL AGAIN. IF WHEEL TURNS, HYDRAULIC PRESSURE WAS TRAPPED IN SYSTEM.

YES: CONTAMINATED FLUID, SEALS SWOLLEN

MASTER CYLINDER NOT RELEASING FULLY (COMPENSATING). STOP LIGHT SWITCH MISADJUSTED, OR PEDAL BINDING

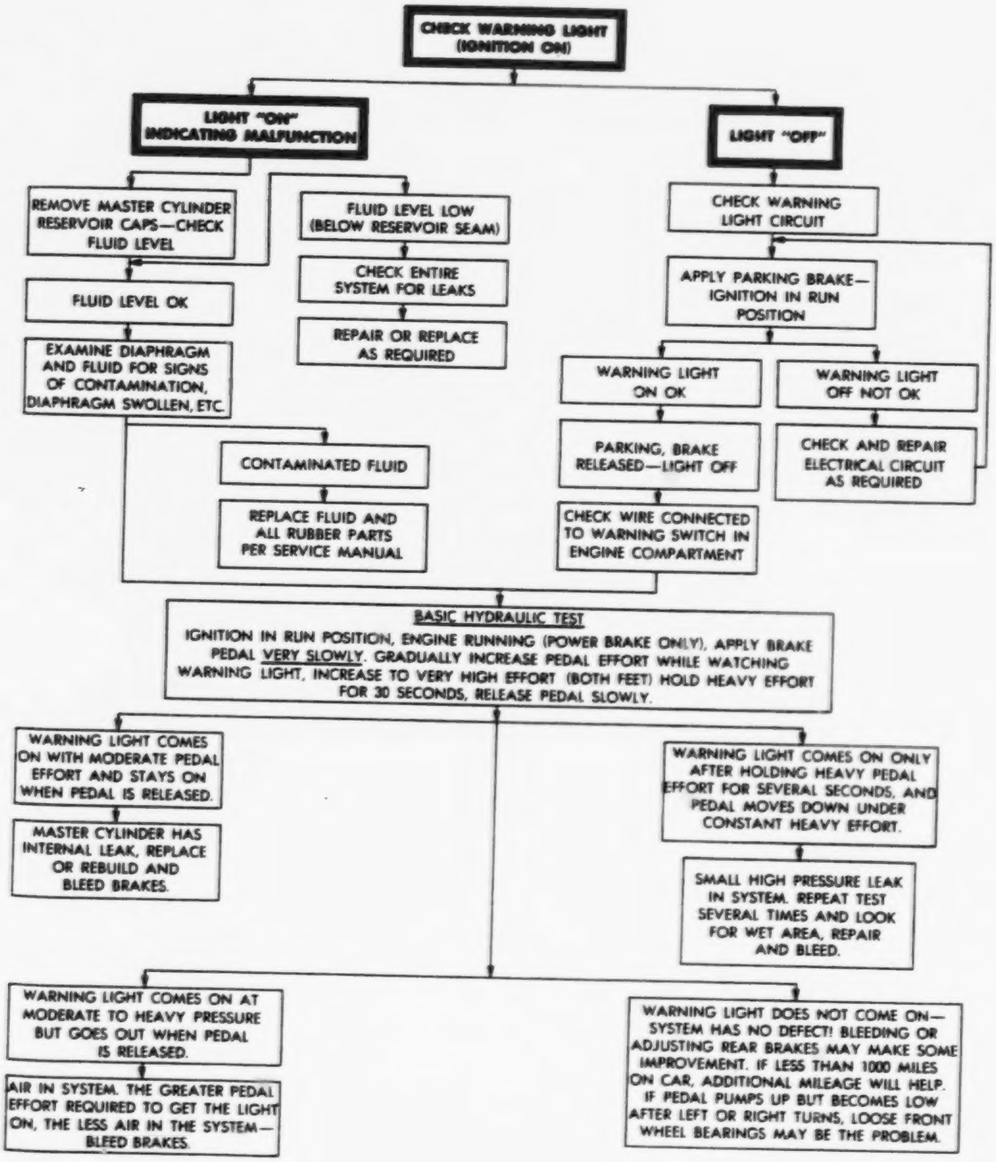
NO: BINDING CALIPER PINS OR BUSHINGS REPLACE BUSHINGS

6 **PEDAL GOES TO FLOOR (POWER) NO WARNING LIGHT**

BOOSTER RUNOUT (MAXIMUM ASSIST POINT) IS OFTEN MISTAKEN FOR THE PEDAL HITTING THE FLOOR ESPECIALLY WHEN THE CAR IS NOT MOVING. THE CHANGE IN PEDAL EFFORT AT RUNOUT IS INTERPRETED AS BOTTOMING THE PEDAL. CHECK BY OPENING A FITTING AND ALLOW THE PEDAL TO MOVE FURTHER

CHECK BOOSTER VACUUM HOSE AND ENGINE. TUNE FOR ADEQUATE VACUUM.

CHART 2—ACTUATION



CHECK WARNING LIGHT (IGNITION ON)

LIGHT "ON" INDICATING MALFUNCTION

REMOVE MASTER CYLINDER RESERVOIR CAPS—CHECK FLUID LEVEL

FLUID LEVEL OK

EXAMINE DIAPHRAGM AND FLUID FOR SIGNS OF CONTAMINATION, DIAPHRAGM SWOLLEN, ETC.

CONTAMINATED FLUID

REPLACE FLUID AND ALL RUBBER PARTS PER SERVICE MANUAL

FLUID LEVEL LOW (BELOW RESERVOIR SEAM)

CHECK ENTIRE SYSTEM FOR LEAKS

REPAIR OR REPLACE AS REQUIRED

LIGHT "OFF"

CHECK WARNING LIGHT CIRCUIT

APPLY PARKING BRAKE—IGNITION IN RUN POSITION

WARNING LIGHT ON OK

PARKING, BRAKE RELEASED—LIGHT OFF

CHECK WIRE CONNECTED TO WARNING SWITCH IN ENGINE COMPARTMENT

WARNING LIGHT OFF NOT OK

CHECK AND REPAIR ELECTRICAL CIRCUIT AS REQUIRED

BASIC HYDRAULIC TEST

IGNITION IN RUN POSITION, ENGINE RUNNING (POWER BRAKE ONLY), APPLY BRAKE PEDAL VERY SLOWLY. GRADUALLY INCREASE PEDAL EFFORT WHILE WATCHING WARNING LIGHT, INCREASE TO VERY HIGH EFFORT (BOTH FEET) HOLD HEAVY EFFORT FOR 30 SECONDS, RELEASE PEDAL SLOWLY.

WARNING LIGHT COMES ON WITH MODERATE PEDAL EFFORT AND STAYS ON WHEN PEDAL IS RELEASED.

MASTER CYLINDER HAS INTERNAL LEAK, REPLACE OR REBUILD AND BLEED BRAKES.

WARNING LIGHT COMES ON ONLY AFTER HOLDING HEAVY PEDAL EFFORT FOR SEVERAL SECONDS, AND PEDAL MOVES DOWN UNDER CONSTANT HEAVY EFFORT.

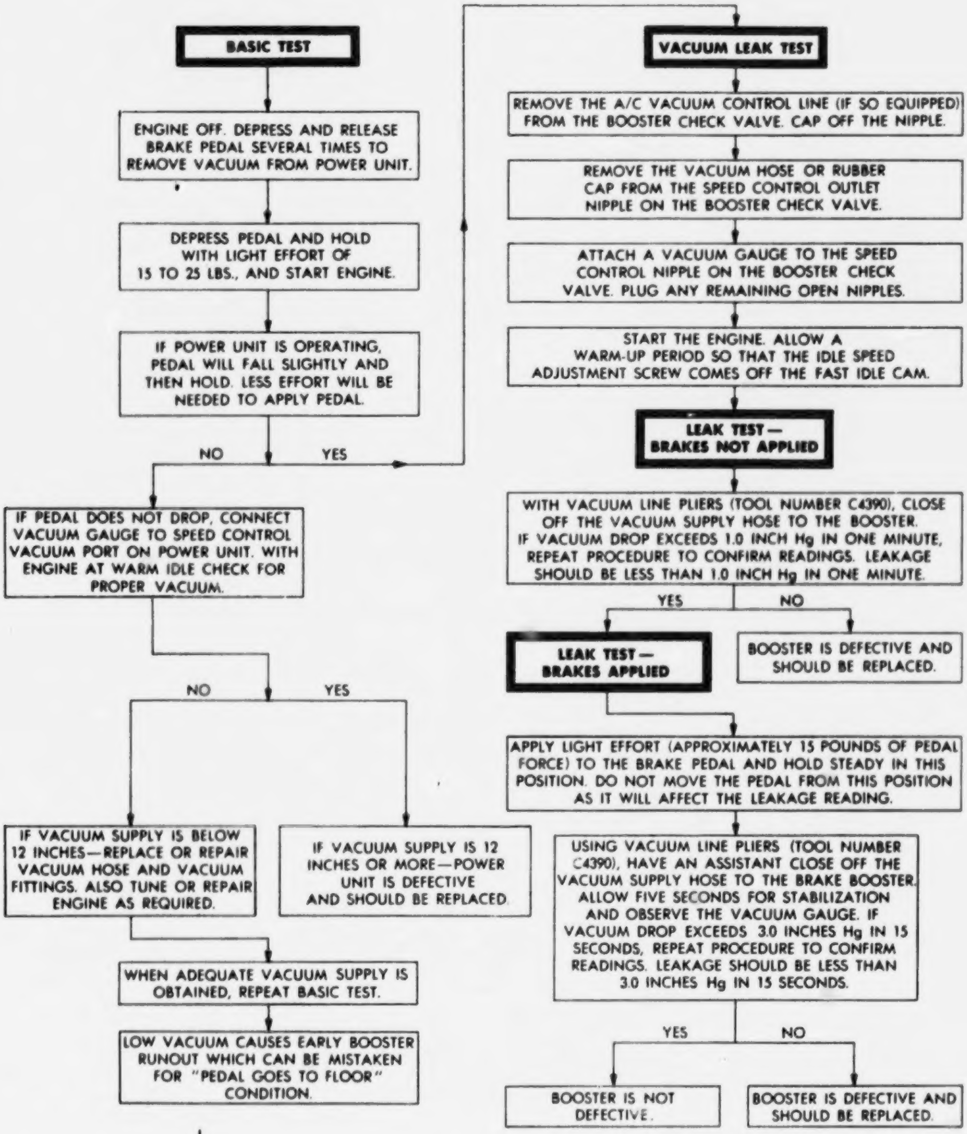
SMALL HIGH PRESSURE LEAK IN SYSTEM. REPEAT TEST SEVERAL TIMES AND LOOK FOR WET AREA, REPAIR AND BLEED.

WARNING LIGHT COMES ON AT MODERATE TO HEAVY PRESSURE BUT GOES OUT WHEN PEDAL IS RELEASED.

AIR IN SYSTEM. THE GREATER PEDAL EFFORT REQUIRED TO GET THE LIGHT ON, THE LESS AIR IN THE SYSTEM—BLEED BRAKES.

WARNING LIGHT DOES NOT COME ON—SYSTEM HAS NO DEFECT! BLEEDING OR ADJUSTING REAR BRAKES MAY MAKE SOME IMPROVEMENT. IF LESS THAN 1000 MILES ON CAR, ADDITIONAL MILEAGE WILL HELP. IF PEDAL PUMPS UP BUT BECOMES LOW AFTER LEFT OR RIGHT TURNS, LOOSE FRONT WHEEL BEARINGS MAY BE THE PROBLEM.

CHART 3—POWER BRAKES



BASIC TEST

ENGINE OFF. DEPRESS AND RELEASE BRAKE PEDAL SEVERAL TIMES TO REMOVE VACUUM FROM POWER UNIT.

DEPRESS PEDAL AND HOLD WITH LIGHT EFFORT OF 15 TO 25 LBS., AND START ENGINE.

IF POWER UNIT IS OPERATING, PEDAL WILL FALL SLIGHTLY AND THEN HOLD. LESS EFFORT WILL BE NEEDED TO APPLY PEDAL.

IF PEDAL DOES NOT DROP, CONNECT VACUUM GAUGE TO SPEED CONTROL VACUUM PORT ON POWER UNIT. WITH ENGINE AT WARM IDLE CHECK FOR PROPER VACUUM.

IF VACUUM SUPPLY IS BELOW 12 INCHES—REPLACE OR REPAIR VACUUM HOSE AND VACUUM FITTINGS. ALSO TUNE OR REPAIR ENGINE AS REQUIRED.

IF VACUUM SUPPLY IS 12 INCHES OR MORE—POWER UNIT IS DEFECTIVE AND SHOULD BE REPLACED.

WHEN ADEQUATE VACUUM SUPPLY IS OBTAINED, REPEAT BASIC TEST.

LOW VACUUM CAUSES EARLY BOOSTER RUNOUT WHICH CAN BE MISTAKEN FOR "PEDAL GOES TO FLOOR" CONDITION.

VACUUM LEAK TEST

REMOVE THE A/C VACUUM CONTROL LINE (IF SO EQUIPPED) FROM THE BOOSTER CHECK VALVE. CAP OFF THE NIPPLE.

REMOVE THE VACUUM HOSE OR RUBBER CAP FROM THE SPEED CONTROL OUTLET NIPPLE ON THE BOOSTER CHECK VALVE.

ATTACH A VACUUM GAUGE TO THE SPEED CONTROL NIPPLE ON THE BOOSTER CHECK VALVE. PLUG ANY REMAINING OPEN NIPPLES.

START THE ENGINE. ALLOW A WARM-UP PERIOD SO THAT THE IDLE SPEED ADJUSTMENT SCREW COMES OFF THE FAST IDLE CAM.

LEAK TEST— BRAKES NOT APPLIED

WITH VACUUM LINE PLIERS (TOOL NUMBER C4390), CLOSE OFF THE VACUUM SUPPLY HOSE TO THE BOOSTER. IF VACUUM DROP EXCEEDS 1.0 INCH Hg IN ONE MINUTE, REPEAT PROCEDURE TO CONFIRM READINGS. LEAKAGE SHOULD BE LESS THAN 1.0 INCH Hg IN ONE MINUTE.

LEAK TEST— BRAKES APPLIED

BOOSTER IS DEFECTIVE AND SHOULD BE REPLACED.

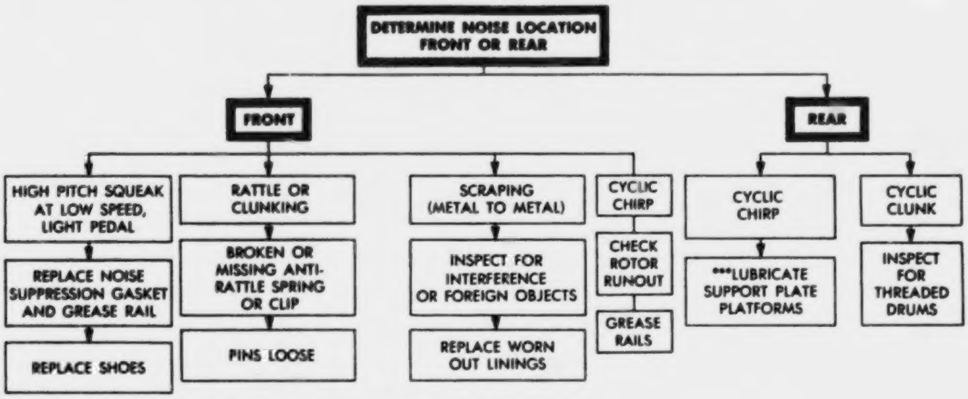
APPLY LIGHT EFFORT (APPROXIMATELY 15 POUNDS OF PEDAL FORCE) TO THE BRAKE PEDAL AND HOLD STEADY IN THIS POSITION. DO NOT MOVE THE PEDAL FROM THIS POSITION AS IT WILL AFFECT THE LEAKAGE READING.

USING VACUUM LINE PLIERS (TOOL NUMBER C4390), HAVE AN ASSISTANT CLOSE OFF THE VACUUM SUPPLY HOSE TO THE BRAKE BOOSTER. ALLOW FIVE SECONDS FOR STABILIZATION AND OBSERVE THE VACUUM GAUGE. IF VACUUM DROP EXCEEDS 3.0 INCHES Hg IN 15 SECONDS, REPEAT PROCEDURE TO CONFIRM READINGS. LEAKAGE SHOULD BE LESS THAN 3.0 INCHES Hg IN 15 SECONDS.

BOOSTER IS NOT DEFECTIVE.

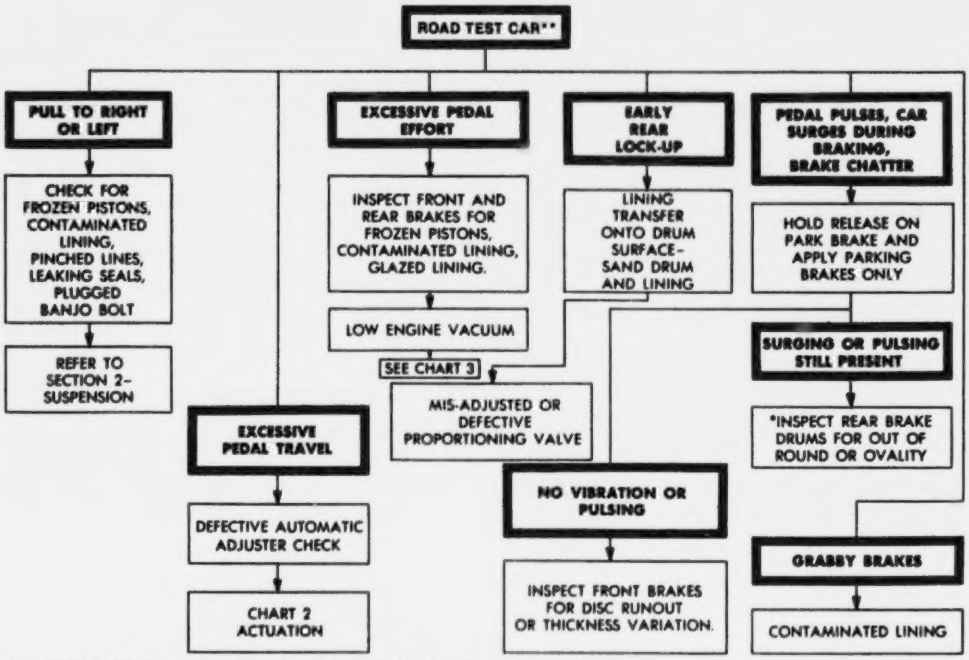
BOOSTER IS DEFECTIVE AND SHOULD BE REPLACED.

CHART 4—BRAKE NOISE


DETERMINE NOISE LOCATION FRONT OR REAR
FRONT
REAR
HIGH PITCH SQUEAK AT LOW SPEED, LIGHT PEDAL
REPLACE NOISE SUPPRESSION GASKET AND GREASE RAIL
REPLACE SHOES
RATTLE OR CLUNKING
BROKEN OR MISSING ANTI-RATTLE SPRING OR CLIP
PINS LOOSE
SCRAPING (METAL TO METAL)
INSPECT FOR INTERFERENCE OR FOREIGN OBJECTS
REPLACE WORN OUT LININGS
CYCLIC CHIRP
CHECK ROTOR RUNOUT
GREASE RAILS
CYCLIC CHIRP
***LUBRICATE SUPPORT PLATE PLATFORMS
CYCLIC CLUNK
INSPECT FOR THREADED DRUMS

***MOPAR MULTIPURPOSE LIUBRICANT, PART NUMBER 4318062, OR EQUIVALENT.

CHART 5—WHEEL BRAKES


ROAD TEST CAR**
PULL TO RIGHT OR LEFT
CHECK FOR FROZEN PISTONS, CONTAMINATED LINING, PINCHED LINES, LEAKING SEALS, PLUGGED BANJO BOLT
REFER TO SECTION 2-SUSPENSION
EXCESSIVE PEDAL TRAVEL
DEFECTIVE AUTOMATIC ADJUSTER CHECK
CHART 2 ACTUATION
EXCESSIVE PEDAL EFFORT
INSPECT FRONT AND REAR BRAKES FOR FROZEN PISTONS, CONTAMINATED LINING, GLAZED LINING.
LOW ENGINE VACUUM
SEE CHART 3
MIS-ADJUSTED OR DEFECTIVE PROPORTIONING VALVE
EARLY REAR LOCK-UP
LINING TRANSFER ONTO DRUM SURFACE-SAND DRUM AND LINING
NO VIBRATION OR PULSING
INSPECT FRONT BRAKES FOR DISC RUNOUT OR THICKNESS VARIATION.
PEDAL PULSES, CAR SURGES DURING BRAKING, BRAKE CHATTER
HOLD RELEASE ON PARK BRAKE AND APPLY PARKING BRAKES ONLY
SURGING OR PULSING STILL PRESENT
*INSPECT REAR BRAKE DRUMS FOR OUT OF ROUND OR OVALITY
GRABBY BRAKES
CONTAMINATED LINING

*PULSATION CAUSED BY REAR BRAKES MAY BE ELIMINATED OR REDUCED BY INDEXING DRUM (REAR) TWO STUDS ON AXLE FLANGE.

**WARNING: Before test driving any car, first check the fluid level in master cylinder, depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low speed stops to be sure that the brakes are safe for road testing.

1. According to the Chrysler Basic Diagnosis Guide, the *most likely* cause of excessive pedal travel can be found on which chart?

2. Under which Chart 1 headings would the specialist find the troubleshooting procedure and corrective actions for dragging front brakes?

3. Which chart would aid the specialist in determining the cause and corrective procedure for a brake pedal that pulsates during braking?

4. The brake warning light is on, indicating a malfunction. You find that the master cylinder fluid is at the correct level, but the master cylinder diaphragm shows signs of contaminated fluid. What corrective action should you take?

5. You are performing a vacuum leak test without applying the brakes. What is the maximum allowable amount of leakage?

6. You are checking a vehicle that requires excessive pedal effort, and determine that the cause is low engine vacuum. What corrective action do you take?

7. What might be the cause of a rattle at the front of the vehicle if you determine that it is not caused by a broken or missing antirattle spring or clip?

8. The pedal on the vehicle you are servicing pulsates. When you hold the release on the parking brake and apply the parking brakes only, no vibrating or pulsing occurs. What corrective action should you take?

9. The customer has complained of a repeated chirping sound in the front of the vehicle. What chart would you use to aid in your diagnosis, and what corrective actions would you take?

10. What might be the causes of premature wheel lockup?

11. According to Chart 1, in what section of the service manual would the specialist find the corrective measures to take for an inoperative proportioning valve?

12. What should the specialist check for if the vehicle pulls to the right or left?

13. What is the first thing the specialist should do when there is a problem with the wheel brakes?

14. What is the first thing that the specialist should do if the brake warning light will not come on?

15. What condition might binding caliper pins or bushings cause?

ACTIVITY ANSWERS

SERVICE DISC BRAKES

ACTIVITY SHEET 1

1. a
2. c
3. b
4. c
5. d
6. b
7. c
8. d
9. d
10. c
11. a
12. b
13. a
14. c
15. d
16. b
17. a
18. a
19. c
20. b
21. c
22. b
23. d
24. b
25. c

ACTIVITY SHEET 2

1. Chart 2—Actuation
2. Chart 1—Misc. Cond., Chart 2—Actuation
3. Chart 5—Wheel Brakes
4. Replace fluid and all rubber parts per service manual
5. Leakage should be less than 1.0 inch Hg in one minute
6. Check booster vacuum hose and engine; tune for adequate vacuum
7. Loose pins
8. Inspect front brakes for disc runout or thickness variation
9. Chart 4—Brake Noise; check rotor runout and grease rails
10. Lining transfer onto drum surface, misadjusted or defective proportioning valve
11. "Hydraulic System Control Valves" section
12. Frozen pistons, contaminated linings, pinched lines, leaking seals, plugged banjo bolt
13. Road test vehicle
14. Check warning light circuit
15. Front or all brakes drag

JOB SHEET 1

SERVICE DISC BRAKES

OBJECTIVE 7

Remove, clean, inspect, and reinstall caliper assembly and brake pads

INTRODUCTION

Essentially, the front disc brake assembly operates in the following manner. A clamping device, or caliper, is mounted around a rotating disc, or rotor, to which the wheel is attached. The clamping action of the caliper presses a pair of shoe pads against the sides of the rotor. The resulting friction slows the rotor, which in turn slows the wheel.

The shoe pads are activated by one or more pistons forced out of bores in the caliper by hydraulic pressure. The caliper may have one, two, or four pistons, depending on the design, although most vehicles have single-piston calipers. Single-piston calipers are usually called *sliding calipers*.

Sliding or floating calipers usually must be lifted off the rotor for pad replacement. Fixed calipers may have pads that can be replaced by removing retaining pins or clips instead of having to lift off the entire caliper.

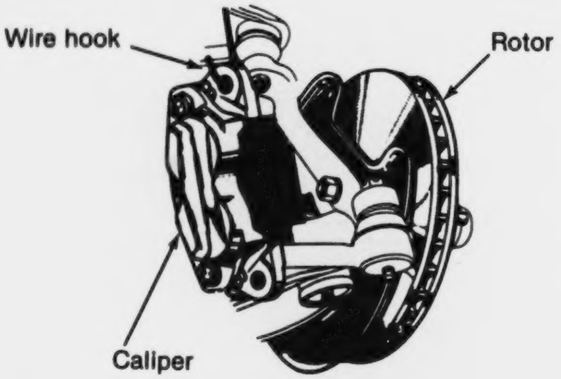
Because there is such a wide variety of caliper designs, service procedures vary considerably. Because of this, proper removal and installation procedures can be found only in the manufacturer's service manual. Certain precautions and guidelines, however, must be considered when removing, cleaning, inspecting, and reinstalling front disc brake calipers and shoe pads. These guidelines and precautions are listed below and on the following pages.

General guidelines

- Before beginning brake work, remove about half of the brake fluid from master cylinder reservoir, and discard.
- Before removing brake pads, check for hydraulic leaks by depressing brake pedal (with engine running on power-brake-equipped vehicles).
- Do not install new pads with another caliper removed to avoid displacing the pistons of the other caliper.
- Keep grease, oil, and brake fluid off caliper, rotor, and pad-and-lining assemblies.
- Do not press brake pedal when pads are out or caliper is off rotor.

- Never allow caliper assembly to hang by brake hose; support caliper or suspend it from frame with a strong piece of wire as shown in Figure 1.

FIGURE 1



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- Make sure that caliper bleed screws can be opened.

  NOTE: If bleed screws are frozen with corrosion, it is sometimes possible to free them with penetrating oil and a small ball-peen hammer and tightening and then loosening to break loose. If they cannot be loosened, they can be drilled out and the caliper retapped for an insert, or the caliper can be replaced with a rebuilt or new unit.

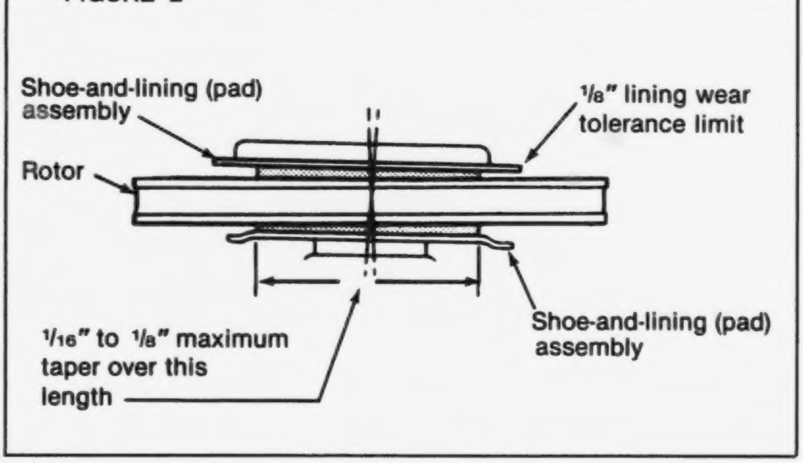
- Check brake pad wear at least every 10,000 miles under normal driving operations.

- When removing pads from calipers, note positions of shims, antirattle clips, keys, bushings, pins, etc., to facilitate reassembly.

- Replace pads when lining is worn 1/8 inch above metal backing plate or 1/16 inch over rivets, when disc pad lining is contaminated with brake fluid or grease, or when it is loose on the metal backing.

- Replace linings that are tapered and worn unevenly if the difference in thickness from one end of pad to other exceeds 1/16 inch on fixed calipers, or 1/8 inch on floating calipers as shown in Figure 2 on the following page.

FIGURE 2


Shoe-and-lining (pad) assembly
1/8" lining wear tolerance limit
Rotor
Shoe-and-lining (pad) assembly
1/16" to 1/8" maximum taper over this length

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- If rotor contains grooves, scoring, nicks, or deep scratches, it should be replaced or machined (see Job Sheet 4).

- Remove glazing, contamination, or light corrosion from rotor with 80-grit sandpaper.

- If installing new pads, inspect caliper assembly for leakage and rebuild or replace the caliper if necessary.

  NOTE: Because new pads are thicker than the worn-out set, they position the piston(s) deep in its bore. Therefore, part of the piston(s) that was subject to debris and corrosion will now contaminate the bore and may cause the hydraulic seal to leak.

- Always replace bushings, O rings, antirattle clips and other small hardware to ensure a dependable brake job.

- Be very careful not to stretch or twist the brake fluid hose (keep the alignment stripe—if present—straight), and use a new copper washer in the hose connection.

- Clean all sliding surfaces to remove burrs and corrosion, and lubricate where specified *only* with *approved* lubricant.

- Bleed brakes and check to be sure that the brake pedal is high and hard before road testing vehicle.

Safety precautions

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

- When operating the engine, be sure that transmission lever is in neutral or park, and make sure that area is properly ventilated for exhaust fumes.
- Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.
- Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 2

SERVICE DISC BRAKES

OBJECTIVE 8

Recondition a disc brake caliper

INTRODUCTION

Caliper reconditioning includes all operations required to restore the caliper and its parts to the manufacturer's specifications. Frozen pistons, leaks, and damaged dust boots are all causes for caliper reconditioning.

Calipers must be removed from the vehicle when they are reconditioned. When you removed and replaced brake shoes, you removed various types of calipers, but you did not disconnect them from the hydraulic system. In most cases of caliper reconditioning, you have to remove only a brake hose or line. Because there is such a wide variety of caliper designs, however, the reconditioning procedure varies considerably. For this reason, the proper reconditioning procedure can be found only in the manufacturer's service manual. Certain general precautions and guidelines should be observed, no matter what caliper design is being serviced, and these are listed below and on the following pages.

General guidelines

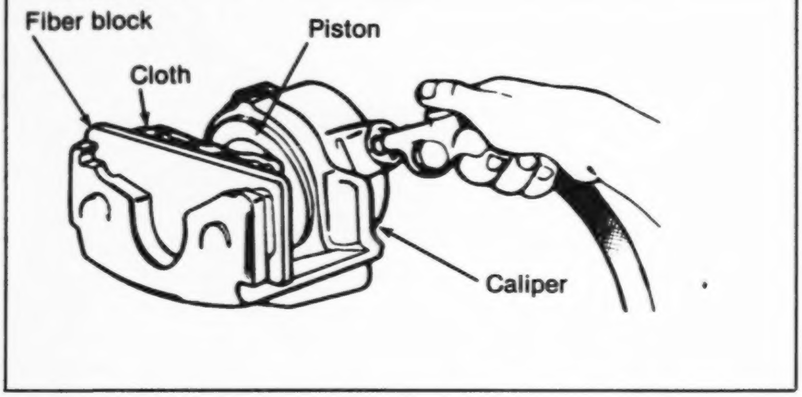
- Recondition, install, and bleed one caliper before starting work on another.

  There are two reasons for completing work on one wheel before starting the next. First, some calipers fit on either side of the vehicle; therefore, it is easy to switch them during installation. Although the calipers will fit in place, the position of the bleeder valve will not allow all air to escape from the cylinder during bleeding. Second, the caliper pistons must be removed from their cylinders, and it is much easier and safer to push them out hydraulically while they are still on the vehicle than to blow them out with air pressure on the bench.

- When reconditioning a caliper that has been removed from the vehicle, place a padded piece of cloth supported by a wooden or fiber block in caliper opening as shown in Figure 1 on the following page to protect the piston when it is blown out with compressed air.

  The pistons **cannot** be blown out of multiple-piston calipers. To remove the pistons from these calipers, remove the caliper from the car with the two halves separated. Mount caliper in vise and use a piston puller to remove the pistons.

FIGURE 1



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- Place caliper between padded vise jaws, and avoid clamping too tightly as clamping too tightly may distort the cylinder bore so that the piston will no longer fit.

- Follow parts-cleaning procedures and use cleaning products recommended by service manual. For example, the use of alcohol or alcohol-based cleaning fluids is not recommended by all manufacturers. Traces of alcohol may remain in the cylinder. Since alcohol has a low boiling point, any of it left in the cylinder might lower the boiling point of the brake fluid.

- Ignore black stains on the piston; they are caused by the piston seal and are a normal condition.

- In some cases, it may be possible to salvage a scored or pitted caliper by honing. However, most vehicle makers advise against the use of abrasives on the cylinder walls. Always consult the service manual for recommendations concerning the vehicle on which you are working.

- Use only an approved assembly lubricant. Some manufacturers recommend the use of specially formulated brake part lubricant. Others recommend the use of brake fluid. Consult the service manual for recommendations concerning the vehicle on which you are working.

- If parking brake is Delco-Moraine-type, replace parking brake thrust washer, seals, and any damaged parts while caliper is removed from vehicle (See Job Sheet 7).

Safety precautions

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

- When operating the engine, be sure that transmission lever is in neutral or park, and make sure that area is properly ventilated for exhaust fumes.
- Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin, and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.
- Cover caliper assembly to contain fluid.
- Be very careful to keep your fingers out of the way when attempting to remove a piston with compressed air; the piston is ejected with enough force to sever a finger.

CAUTION

Removal of piston from caliper with compressed air can be dangerous. Follow vehicle manufacturer's instructions.

- Before test driving any vehicle check the fluid level in master cylinder, and depress the brake pedal to be sure there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 3

SERVICE DISC BRAKES

OBJECTIVE 9

Clean, inspect, and measure a rotor with dial indicator and micrometer

INTRODUCTION

Disc brake problems are mainly related to improper fits and distortions of flat surfaces that can be inspected, measured, and diagnosed more accurately than the curved surfaces and shoe alignments of drum brakes.

Typical disc brake conditions that need careful inspection include *lateral runout*, a wobbly movement of the rotor from side to side as it rotates, and *lack of parallelism*, excessive variations in rotor thickness.

Excessive lateral runout can be caused by a warped rotor, incorrect torquing of lug nuts, warpage, or excessive heat. Excessive lateral runout causes the rotor to knock the pads back and can result in chatter, excessive pedal travel, a pumping or pulsating pedal, and vibration during braking.

Lack of parallelism can cause pedal vibration and pulsation, excessive pedal travel, grabby braking action, and front-end vibrations.

This job-sheet procedure is for disc brakes on *nondrive* wheels. Procedures vary for disc brakes on *drive* wheels, and you must refer to the vehicle manufacturer's instructions.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Rubber mallet
- Replacement cotter pins
- Solvent for cleaning dust cap
- Diagonal cutting pliers
- Hub cap remover
- Torque wrench
- Shop towels and lint-free cloths
- Recommended cleaning fluid
- Dial indicator
- Micrometer

- Brake system inspection report form

► WARNING ◄

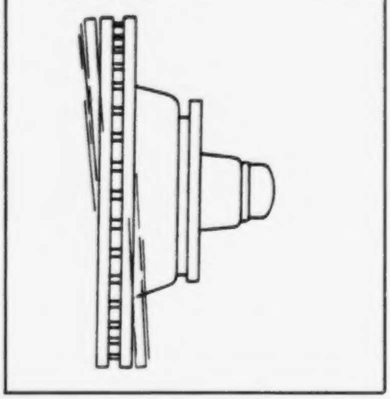
Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

NOTE: Be sure to note all inspection findings on your brake system inspection report form.

1. Cover fenders and seat
2. Raise vehicle and support safely
3. Remove tire-and-wheel assemblies, and suspend calipers
4. Clean rotors with solvent recommended by vehicle manufacturer
5. Measure rotor for lateral runout (See Figure 1)

FIGURE 1



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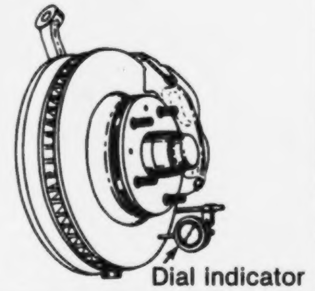
   a. Tighten wheel spindle nut to specified rotor-checking torque, with all end play removed

   b. Fasten dial indicator to suspension at a convenient place, making sure that indicator stylus contacts rotor face about 1 inch from rotor's outer edge (See Figure 2)

FIGURE 2



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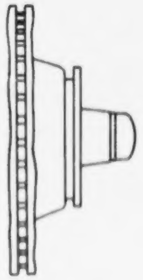
c. Check total indicator reading (t.i.r.) while turning rotor one full revolution; *if* rotor is warped beyond vehicle manufacturer's specifications, it must be replaced or resurfaced (See Job Sheet 4)

6. Measure rotor for correct parallelism (Figure 3)

FIGURE 3



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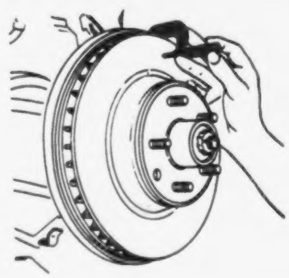
a. Place micrometer on rotor about 1 inch from rotor edge (Figure 4)

FIGURE 4



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   b. Measure and record rotor thickness

   c. Repeat measuring and recording procedure at four more equally spaced points on rotor

   d. Subtract smallest reading from largest reading, and compare this figure to the specification for the vehicle

      NOTE: This specification is usually less than 0.011 inch.

   e. If rotor is excessively out of parallel, it must be replaced or resurfaced (See Job Sheet 4)

7. Readjust wheel bearings

8. Reinstall calipers and tire-and-wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub

9. Lower vehicle to floor

10. Torque lug nuts to manufacturer's specifications

11. Install wheel covers, tapping in place with rubber mallet

12. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

13. Clean work area and return equipment and materials to proper storage

JOB SHEET 4

SERVICE DISC BRAKES

OBJECTIVE 10

Resurface a rotor

INTRODUCTION

Except for those defects that require actual replacement of the rotor, most rotor defects such as scoring, runout, and incorrect parallelism are corrected by resurfacing the rotor on a brake lathe with a twin cutter tool attachment. As the rotor turns on the lathe, the twin cutter tool shaves metal from both sides of the rotor to a specified thickness.

Vehicle manufacturers specify a minimum allowable rotor thickness and this specification is stamped on the rotor. Machining a rotor until it is thinner than the specified minimum thickness could permit the rotor to wear past the safe discard point before the linings wear out. It could also cause severe overheating and, as the linings become worn, could cause the pads to be forced out far enough to jam the brakes. For these reasons, the brakes specialist should always consult the service manual for the vehicle being worked on to find the minimum allowable rotor thickness.

After a rotor has been resurfaced, it is then refaced. This removes any remaining minor imperfections and provides a nondirectional finish on the surface of the rotor. A special sanding disc is attached to the brake lathe to accomplish this task.

A rotor can be resurfaced using a disc brake lathe, or it can be resurfaced using a drum brake lathe with special refinishing attachments. The procedures for resurfacing the rotors of nondrive and drive wheels of different vehicles vary. Since the equipment and procedures used to resurface a rotor vary, always consult the appropriate vehicle service manual and lathe operating manual when performing this procedure. There are, however, certain precautions and guidelines that should always be followed when resurfacing a rotor, and they are listed below and on the following page.

General guidelines

- Before resurfacing a rotor, consult the vehicle service manual for the minimum thickness allowed after refinishing. In some cases, the amount of cut from the friction surface of the rotor to obtain a smooth finish will not leave an acceptable rotor thickness; therefore, the rotor should be replaced.
- Always resurface both rotors; even if only one rotor needs resurfacing, vehicle manufacturers recommend that both be resurfaced at the same time.

- Always consult manufacturer's instructions for amount to be cut from the friction surface at one time.

- Rotors that are only lightly rusted, glazed, or scored, or those with little runout or lack of parallelism may require only one cut of the friction surfaces, rather than two or more cuts.

- Always be sure that the adapters and arbor are clean and free of metal chips and grease and that arbor is not damaged in any way. Contaminants or defects on the lathe arbor or the adapters will result in inaccurate rotor refinishing.

- Always consult the lathe manufacturer's operating manual for exact method of mounting the sanding attachment on the brake lathe.

- Do not handle the rotor with greasy hands or otherwise contaminate the friction surface of rotor after resurfacing.

Safety precautions

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

- Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 5

SERVICE DISC BRAKES

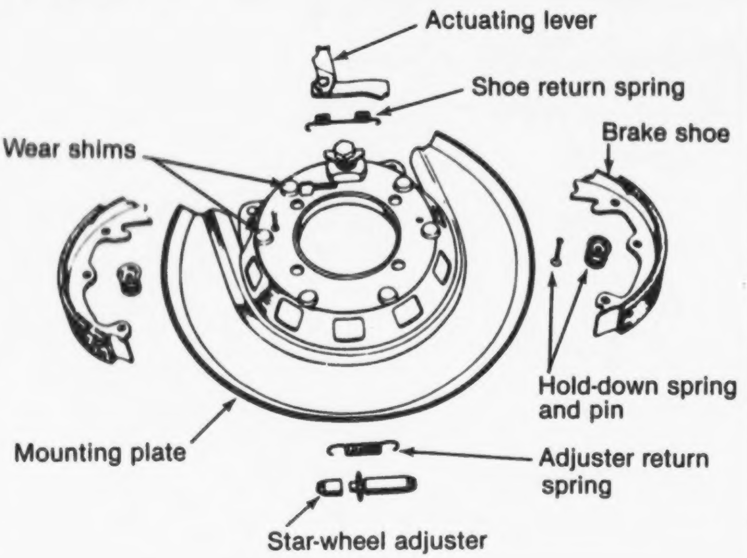
OBJECTIVE 12

Overhaul and adjust rear disc/drum (auxiliary drum) parking brake

INTRODUCTION

The independent parking brake on vehicles equipped with rear disc brakes is different than the integrated parking brakes found on vehicles with rear drum brakes. With this type of parking brake, the inner surface of the rotor serves as a drum and is fitted with a small pair of drum-type shoes. The components of the parking brake assembly of the rear disc/drum parking brake are shown in Figure 1 below.

FIGURE 1


Actuating lever
Shoe return spring
Brake shoe
Wear shims
Hold-down spring and pin
Mounting plate
Adjuster return spring
Star-wheel adjuster

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Shoe-to-drum clearance is adjusted manually at the star wheel just as it is in regular drum brakes. When servicing this type of parking brake, however, the technician should check for the following:

- Free movement of the parking brake cables in the conduits
- Worn equalizer and linkage parts
- Broken strands in the cables

This job sheet will give you practice in the skills necessary to overhaul and adjust the rear disc/drum parking brake.

EQUIPMENT AND MATERIALS

- Vehicle
- Eye protection
- EPA-approved asbestos safety equipment and protective clothing
- Fender and seat covers
- Brake parts washer and approved solvent
- Star-wheel adjusting tool
- Brake spring pliers
- Approved lubricant
- Appropriate replacement parts
- Shop clothes
- Hydraulic lift or jack and jack stands
- Rubber mallet
- Basic hand-tool set
- Appropriate service manual

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Cover fenders and seats
2. Release parking brake
3. Raise vehicle and support safely
4. Remove rear tire-and-wheel assemblies
5. Remove rear wheel parking brake assembly, backing off adjustment of shoes, if necessary, by following vehicle manufacturer's instructions

   NOTE: It may be necessary to adjust star wheel in order to remove the rear wheel parking brake assembly.

6. Spread shoes and remove adjuster assembly, taking care **not** to damage shims on mounting plate during disassembly

   CAUTION

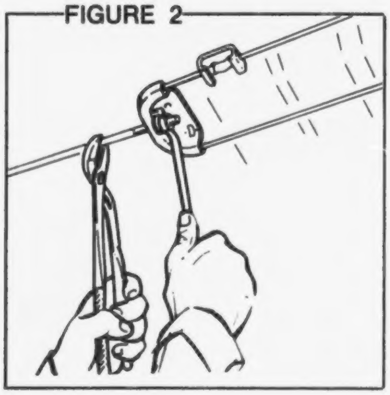
   Be very careful **not** to damage the wear shims on the mounting plate during any step of this procedure. *If* the shims are damaged, the entire mounting plate assembly must be replaced.

7. Remove adjuster return spring
8. Remove hold-down springs by pushing down on spring and sliding pin over until it can be removed with appropriate tool through hole at end of slot
9. Remove shoe return spring

10. Remove both shoes
11. Clean and inspect star-wheel adjuster assembly; lubricate threads with approved lubricant
12. Clean and inspect wear bracket and wear shims

    NOTE: If wear bracket or wear shims are damaged, the entire mounting plate must be replaced.
13. Clean and inspect rubber boot; *if* it is worn or cracked, replace
14. Clean and inspect hardware
15. Lubricate wear bracket and shims with approved lubricant
16. Reinstall shoes, making sure that actuating lever and strut assembly are positioned on wear shims
17. Reinstall shoe return spring
18. Reinstall hold-down springs and pins
19. Reinstall adjuster return spring
20. Reinstall star-wheel adjuster
21. Position parking brake assembly on hub and hold down with two lugs
22. Adjust shoe-to-drum clearance by tightening adjuster until rotor cannot be moved and then backing off ten notches from this fully expanded position
23. Repeat steps 5 through 22 for other rear wheel
24. Apply parking brake lever or pedal from inside the vehicle to position specified in vehicle manufacturer's service manual
25. Adjust parking brake cable link at equalizer underneath vehicle to produce light drag (Figure 2)

FIGURE 2



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26. Compete installation of both parking brake assemblies, following instructions in service manual

27. Reinstall rear tire-and-wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub

28. Release parking brake pedal or lever

29. Rotate rear wheels by hand to check for drag; no drag should be noticed

30. Lower vehicle to floor

31. Torque lug nuts to manufacturer's specifications

32. Install wheel covers, tapping in place with rubber mallet

33. Test parking brake for proper operation

34. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing

35. Clean work area and return equipment and materials to proper storage

JOB SHEET 6

SERVICE DISC BRAKES

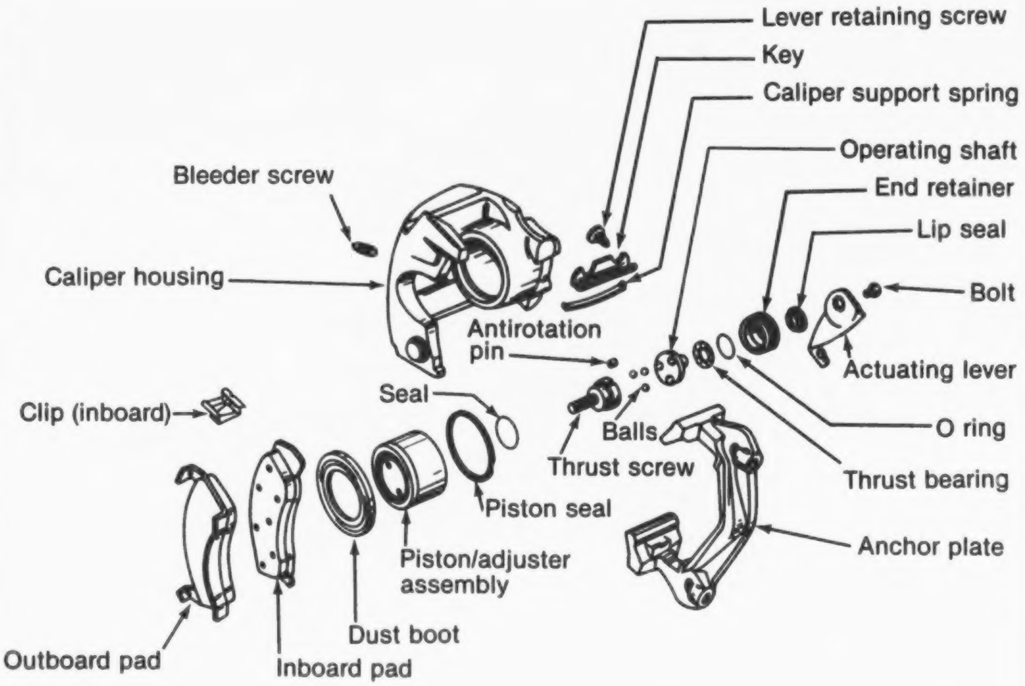
OBJECTIVE 13

Overhaul Kelsey-Hayes-type rear disc brake/parking brake assembly

INTRODUCTION

Kelsey-Hayes rear disc brakes have been used on some Ford vehicles since 1975. This rear disc caliper assembly is similar to the front brake caliper except for an added parking brake and adjuster mechanism that is actuated by the parking brake cable (Figure 1).

FIGURE 1



Lever retaining screw
Key
Caliper support spring
Operating shaft
Bleeder screw
End retainer
Lip seal
Caliper housing
Bolt
Antirotation pin
Actuating lever
Seal
Clip (inboard)
O ring
Balls
Thrust screw
Thrust bearing
Piston seal
Anchor plate
Piston/adjuster assembly
Dust boot
Outboard pad
Inboard pad

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When the parking brake is applied, the lever rotates an operating shaft. There are three balls located in pockets between the operating shaft head and the thrust screw. As the shaft rotation forces these balls up raised areas on the thrust screw head, the thrust screw drives the piston and pad against the rotor. The pressure of the piston on the brake pads holds the rotor in place, acting as a parking brake. An automatic adjuster in the piston assembly moves on the thrust screw to compensate for pad wear and to maintain proper internal clearances.

EQUIPMENT AND MATERIALS

- Vehicle
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Brake parts washer and approved solvent
- Brake adjusting tool
- Piston removing tool
- Magnet or tweezers
- Appropriate replacement parts
- Shop cloths
- Hydraulic lift or jack and jack stands
- Basic hand-tool set
- Isopropyl alcohol
- Source of compressed air
- Approved brake fluid
- Dust boot installing tool
- Bench vise
- Allen wrench, $^{1}/_{4}$-inch
- Silicone grease
- Torque wrench
- Brake bleeding equipment
- Appropriate service manual

► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

PROCEDURE

1. Cover fenders and seats
2. Raise vehicle and support safely
3. Remove tire-and-wheel assembly
4. Disconnect parking brake cable from lever, using care to avoid kinking or cutting cable or return spring
5. Disconnect hydraulic brake line from back of caliper, and plug openings

   NOTE: *If* the line connection is frozen, disconnect the line at the junction block. Plug opening and remove caliper with brake lines attached.

6. Remove caliper from vehicle, following procedure outlined in service manual

7. Place caliper on work bench and remove caliper end retainer (See Figure 1)

8. Lift out operating shaft, thrust bearing, and balls (See Figure 1)

9. Remove antirotation pin with magnet or tweezers

   NOTE: Some antirotation pins may be difficult to remove with a magnet or tweezers. If this is the case, use the following procedure.

   a. Adjust piston out from caliper bore with piston remover until piston protrudes from housing at least 1 inch

   b. Push piston back into caliper housing with adjusting tool; with tool in position on caliper, hold tool shaft in place and rotate handle counterclockwise until thrust screw clears antirotation pin

   c. Remove antirotation pin

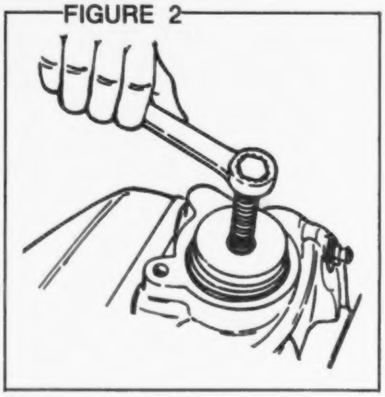
10. Remove thrust screw by rotating it counterclockwise with ¼-inch allen wrench

11. Remove piston/adjuster assembly by installing piston remover through back of caliper housing and pushing piston out (Figure 2)

    CAUTION

    Take care **not** to damage the polished surface in the thrust screw bore and do **not** press on or attempt to remove the adjuster. It is press-fitted in the piston.

FIGURE 2



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12. Remove and discard all rubber parts (boot and seals)

13. Clean all metal parts with isopropyl alcohol; clean and dry passages with compressed air

14. Inspect caliper bores for damage or excessive wear; *if* thrust screw bore is rough or pitted or *if* piston is pitted, scored, or has worn-off chrome plating, replace piston adjuster assembly

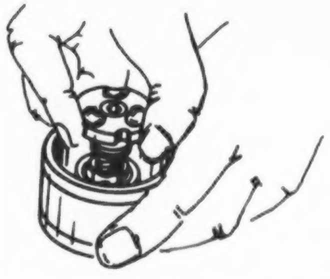
15. Inspect adjuster; *if* adjuster is loose in piston, appears high in piston, or is damaged or *if* brake adjustment problems have occurred during normal operation, replace piston/adjuster assembly

    NOTE: The adjuster must be bottomed in the piston to be properly seated and to provide consistent parking-brake function.

16. Check adjuster operation

    a. Assemble thrust screw into piston assembly (Figure 3)

FIGURE 3



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    b. Pull the two pieces apart by hand approximately ¼ inch, and then release them

    NOTE: When pulling the two pieces apart, the brass drive ring must remain stationary, causing the nut to rotate. When releasing the two parts, the nut must remain stationary and the drive ring must rotate.

    c. *If* action of components does **not** follow pattern described above, replace piston/adjuster assembly

17. Inspect ball pockets, threads, grooves, and bearing surfaces of thrust screws and operating shaft for wear, pitting, or brinnelling; *if* any parts are worn or damaged, replace

18. Inspect thrust bearing, *if* it is badly corroded, pitted, or worn, replace

19. Inspect bearing surface of end plug; *if* worn or brinelled, replace

    NOTE: A polished appearance on the bearing surface is acceptable if there is no sign of erosion on the surface.

20. Inspect lever; *if* damaged, replace

21. Apply a coat of clean, approved brake fluid to new caliper piston seal, and install it in cylinder bore, making sure that seal is **not** twisted and that it is seated fully in groove

22. Install new dust boot by seating flange squarely in outer groove of caliper bore

23. Coat piston/adjuster assembly with clean, approved brake fluid, and install it in cylinder bore, spreading dust boot over piston as it is installed and seating dust boot in piston groove

24. Install caliper in vise and fill piston/adjuster assembly with recommended brake fluid to bottom edge of thrust screw bore

25. Install thrust screw by turning it into piston/adjuster assembly with ¼-inch allen wrench until top surface of thrust screw is flush with bottom of threaded bore

    CAUTION

    Use care to avoid cutting O-ring seal.

26. Index thrust screw so that notches on screw and caliper housing are aligned, and install antirotation pin

    NOTE: The thrust screw and operating shaft are not interchangeable from side to side. The pocket surface of the operating shaft and thrust screw are stamped with the letter R (right) or L (left).

27. Place a ball in each of the three pockets of thrust screw, and apply a liberal amount of silicone grease to all components of parking brake mechanism

28. Install operating shaft on balls

29. Coat thrust bearing with silicone grease, and install it on operating shaft

30. Install new lip seal and O ring in end retainer

31. Coat O-ring seal and lip seal with light film of silicone grease, and install end retainer in caliper, holding operating shaft firmly seated against internal mechanism to prevent mislocation of balls

32. *If* lip seal is pushed out of position, reseat the seal

33. Torque end retainer to specifications

    NOTE: This is usually 75 to 95 foot-pounds.

34. Install parking brake lever on its keyed spline, making sure that it points down and rearward so that parking brake cable can pass freely under axle

35. Torque lever retaining screw to specifications; check to make sure that lever can rotate freely after torqueing

    NOTE: Torqueing specifications are usually 16 to 22 foot-pounds.

36. Holding caliper in vise, bottom piston with piston installing tool

37. Install caliper on vehicle, and reconnect brake lines as specified in service manual, taking care **not** to twist or kink them

    NOTE: If connection at junction block was opened, use two new copper washers when reinstalling line.

38. Repeat steps 3 through 37 for other wheel

39. Bleed rear brake system

40. Connect parking brake cable and adjust if necessary

41. Reinstall tire-and-wheel assemblies, tightening lug nuts in cross pattern just enough so that wheel is snug against hub

42. Lower vehicle to floor

43. Torque lug nuts to manufacturer's specification

44. Install wheel covers, tapping in place with rubber mallet

45. Test parking brake for proper operation

46. Road test vehicle

► WARNING ◄

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

47. Clean work area and return equipment and materials to proper storage

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JOB SHEET 7

SERVICE DISC BRAKES

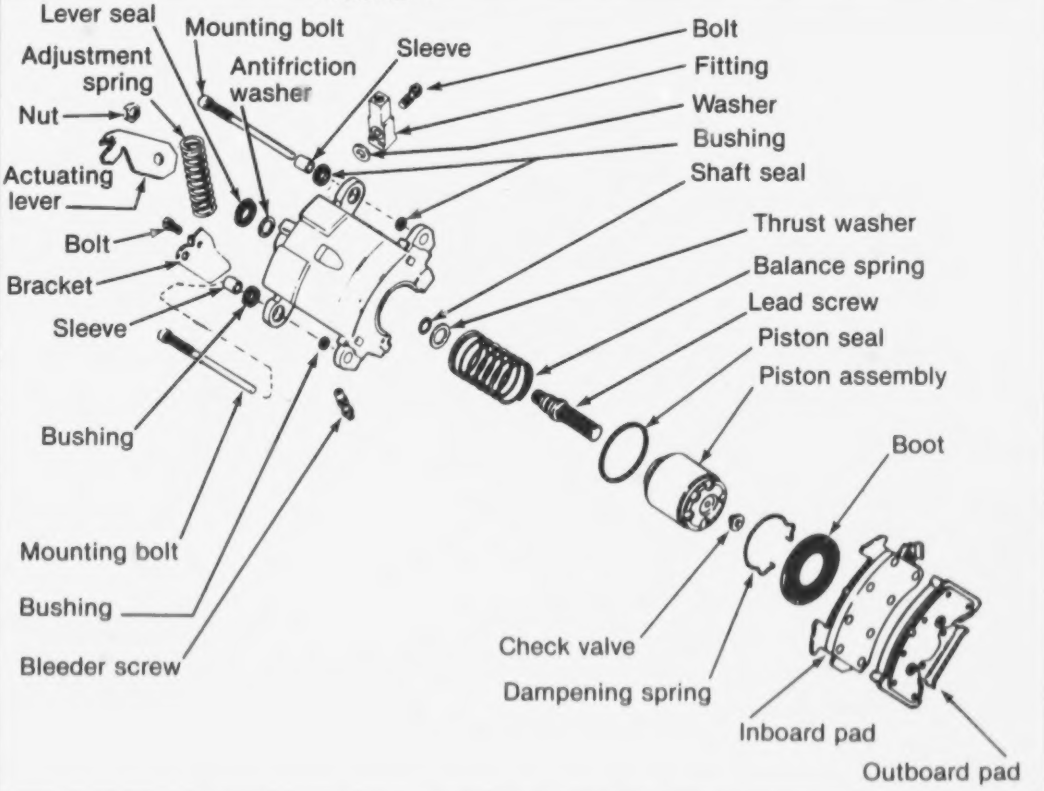
OBJECTIVE 14

Overhaul GM Delco-Moraine-type rear disc brake/parking brake assembly

INTRODUCTION

As with the Kelsey-Hayes rear disc brakes, the GM Delco-Moraine rear brake caliper is similar to the front brake caliper except for the addition of a parking brake mechanism. On this design, the parking brake is operated through a lever on the inboard side of the caliper which is connected to the parking brake cable. The actuating lever is connected to a high lead screw that passes through a nut in the piston. Rotation of the lever moves the piston along the screw, thus engaging the parking brake (Figure 1).

FIGURE 1


Lever seal
Mounting bolt
Adjustment spring
Antifriction washer
Sleeve
Nut
Actuating lever
Bolt
Bracket
Sleeve
Bushing
Mounting bolt
Bushing
Bleeder screw
Bolt
Fitting
Washer
Bushing
Shaft seal
Thrust washer
Balance spring
Lead screw
Piston seal
Piston assembly
Boot
Check valve
Dampening spring
Inboard pad
Outboard pad

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The nut in the piston is spring loaded, permitting piston travel during hydraulic braking. As lining wear allows the piston to move farther out of the bore, the nut is rotated along the lead screw by means of an adjustment spring. Because of this spring action, there is no manual adjustment of this type of parking brake. However, when the caliper is overhauled, the parking brake components should be replaced.

Normally there is no reason to disassemble the parking brake mechanism except during pad replacement or servicing of the regular disc brake. However, it is necessary to remove the actuating lever to remove the caliper from the vehicle.

EQUIPMENT AND MATERIALS

- Vehicle
- Eye protection
- EPA-approved asbestos safety equipment and recommended protective clothing
- Shop cloths
- Hydraulic lift or jack and jack stands
- Basic hand-tool set
- C-clamp
- Silicone grease
- Hex wrench
- Torque wrench
- Piston installer
- Appropriate replacement parts
- Brake bleeding equipment
- Approved brake fluid
- Isopropyl alcohol
- Dust boot installing tool
- Seal driver
- Appropriate service manual

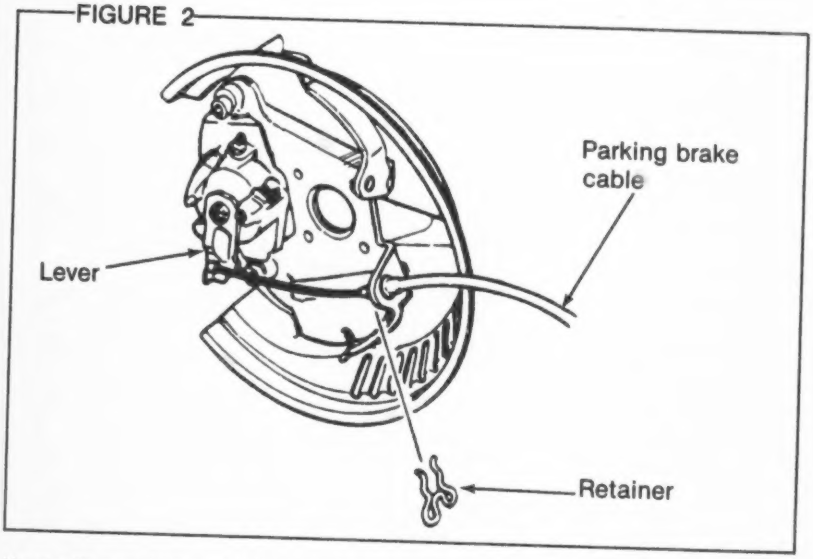
► WARNING ◄

Many brake components may contain asbestos fibers. Breathing asbestos dust is *very* harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules!

PROCEDURE

1. Cover fenders and seats
2. Raise vehicle and support safely
3. Remove tire-and-wheel assembly, and install one wheel lug—flat side toward rotor—to prevent rotor from falling when caliper is removed
4. Loosen tension on parking brake cable at equalizer
5. Remove cable from parking brake actuating lever (See Figure 2)

FIGURE 2



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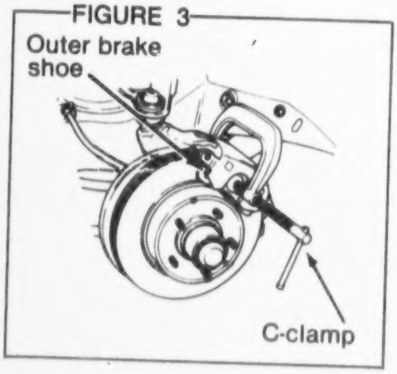
6. Remove cable bracket from caliper
7. Hold actuating lever in place and remove locknut
8. Remove actuating lever, return spring, lever seal, and antifriction washer
9. Position C-clamp over caliper, with solid side against back of caliper assembly and screw side against back of outer pad as shown in Figure 3

CAUTION

Do not place clamp on actuating lever screw.

FIGURE 3



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10. Disconnect hydraulic brake line from back of caliper, and plug openings

    NOTE: *If* the line connection is frozen, disconnect the line at the junction block. Plug openings and remove caliper with brake lines attached.

11. Remove the two mounting bolts that hold caliper to support bracket

12. Lift caliper off rotor and drain fluid through brake bleeder into appropriate container; dispose of brake fluid properly

13. Lubricate area under actuating lever seal with silicone grease

14. Install new antifriction washer, new seal, and actuating lever on hex nut, with arm pointing downward

15. Rotate lever toward front of vehicle and hold in this position while torquing it to 25 foot-pounds; then rotate lever back to its stop

16. Install lever return spring and remove C-clamp

    CAUTION

    Install the correct return spring. Return springs are not interchangeable and are color-coded—red for the right side and black for the left side.

17. Rotate lever back and forth to remove piston

18. *If* piston does not come out, remove nut, lever, seal, and washer, and turn piston out using a wrench on the hex screw, turning clockwise on right-hand caliper and counterclockwise on left-hand caliper

19. Taking care **not** to scratch cylinder bore, remove piston and balance spring, actuating screw, boots, and seals

20. Clean parts and housing with isopropyl alcohol, and blow dry with compressed air

21. Check bore and piston for scratches and pits; *if* damage is found, replace piston

22. Check cavity under check valve; *if* brake fluid is found in cavity, replace piston assembly

23. Install new piston seal in bore

24. Install boot on piston assembly

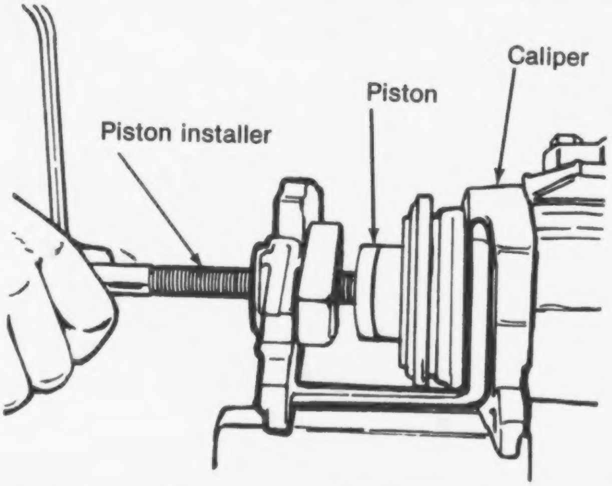
25. Install new thrust washer—with Teflon surface toward housing—and new O-ring seal on screw; lubricate with brake fluid

26. Fit screw into piston assembly, noting that pistons and screws are marked R and L to match letters on caliper

27. Fit balance spring into piston retainer

28. Use piston installer to install piston straight into housing (Figure 4)

FIGURE 4



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29. Before removing piston installer, install antifriction washer lubricated with silicone grease, lever seal, lever, and locknut

30. Push lever down, rotate it forward, tighten locknut, and return lever to its stop

31. Remove piston installer

32. Use seal driver to install piston seal

33. Install dampening spring on pad plate

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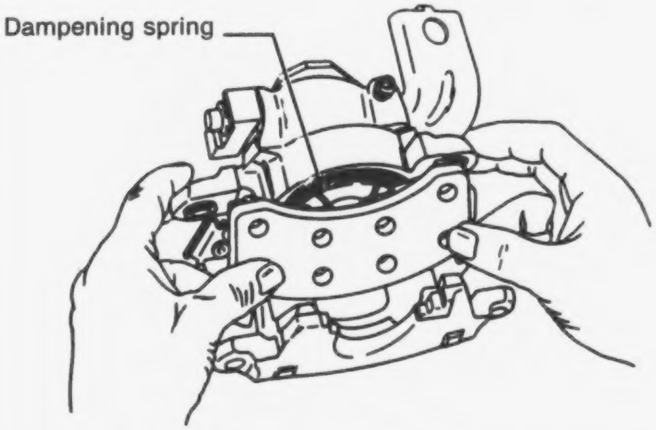
34. Position new inner pad on piston as shown in Figure 5, making sure that D-shaped tab on pad fits in indentation provided

    NOTE: *If* the piston needs to be rotated, use piston remover to rotate it.

FIGURE 5



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35. Use large pliers to seat pad ears over caliper

36. Lubricate O-ring bushings, bushing grooves, sleeves, and tips of both mounting bolts with silicone grease

37. Position caliper over rotor and install mounting bolts; tighten mounting bolts to service manual specifications

38. Reconnect brake lines, taking care **not** to twist or kink them

    NOTE: *If* connection at junction block was opened, use two new copper washers when reinstalling line.

39. Repeat steps 3 through 38 for other wheel

40. Take up piston clearance by actuating parking brake several times

41. Bleed rear brake system

42. Pump brake pedal to seat the pads against rotors

43. Connect parking brake cable to actuating lever on each wheel

44. Work parking brake pedal or lever back and forth, and then check to see whether the lever returns all the way to the stop; *If* the lever does **not** return, more slack is needed—adjust it at equalizer nut

    NOTE: *If* the lever still does not return, even with plenty of cable slack, check the return spring and piston and screw assembly and replace as necessary.

45. On one wheel at a time, remove lug nut that was used to prevent rotor from falling off when caliper was removed

46. Reinstall tire-and-wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub

47. Lower vehicle to floor

48. Torque lug nuts to manufacturer's specifications

49. Install wheel covers, tapping in place with rubber mallet

50. Fill master cylinder with fresh brake fluid

51. Obtain a high, hard pedal by pumping the brake pedal several times firmly but slowly

    NOTE: *If* excess clearance is **not** removed from the automatic adjusting mechanism, a high pedal cannot be obtained. As many as sixty pumps may be necessary.

52. Road test vehicle

    ► WARNING ◄

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

53. Clean work area and return equipment and materials to proper storage

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 1

Remove, clean, inspect, and reinstall caliper assembly and brake pads

Student's name ______________________________ Date __________

Evaluator's name ______________________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Remove caliper assembly following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Properly supported removed caliper.	______	______
5. Removed brake pads following procedure outlined in vehicle manufacturer's service manual.	______	______
6. Correctly determined if brake pad replacement was necessary.	______	______
7. Cleaned appropriate parts as recommended in vehicle manufacturer's service manual.	______	______
8. Replaced or repaired parts as necessary.	______	______
9. Bled brake system.	______	______
10. Completed service correctly.	______	______
11. Observed safety rules and precautions.	______	______
12. Correctly filled out brake system inspection report form.	______	______
13. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 2

Recondition a disc brake caliper

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Disassembled caliper following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Removed pistons from caliper correctly.	______	______
5. Cleaned appropriate parts as recommended in vehicle manufacturer's service manual.	______	______
6. Replaced or repaired parts as necessary.	______	______
7. Completed service correctly.	______	______
8. Observed safety rules and precautions.	______	______
9. Correctly filled out brake system inspection report form.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 3

Clean, inspect, and measure a rotor with dial indicator and micrometer

Student's name ________________________ Date __________

Evaluator's name ________________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	_____	_____
2. Properly prepared vehicle.	_____	_____
3. Measured rotor for runout following outlined procedure.	_____	_____
4. Correctly determined if rotor replacement was necessary.	_____	_____
5. Measured rotor for correct parallelism following outlined procedure.	_____	_____
6. Correctly determined if rotor should be replaced or refinished.	_____	_____
7. Completed service correctly.	_____	_____
8. Observed safety rules and precautions.	_____	_____
9. Correctly filled out brake system inspection report form.	_____	_____
10. Cleaned work area and returned equipment and materials to proper storage.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 4

Resurface a rotor

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Mounted rotor on lathe following procedure outlined in lathe manufacturer's operating manual.	______	______
4. Consulted vehicle manufacturer's service manual for minimum thickness allowed after refinishing and correctly determined if rotor could be resurfaced or if it should be replaced.	______	______
5. Resurfaced rotor following procedure outlined in vehicle manufacturer's service manual and lathe manufacturer's operating manual.	______	______
6. Refaced rotor following procedure outlined in vehicle manufacturer's service manual and lathe manufacturer's operating manual.	______	______
7. Completed service correctly.	______	______
8. Observed safety rules and precautions.	______	______
9. Correctly filled out brake system inspection report form.	______	______
10. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 5

Overhaul and adjust rear disc/drum (auxiliary drum) parking brake

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed rear wheel parking brake assembly following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Disassembled parking brake assembly following outlined procedure.	______	______
5. Cleaned and inspected parts following outlined procedure.	______	______
6. Replaced parts as necessary.	______	______
7. Reassembled parking brake assembly following outlined procedure.	______	______
8. Adjusted shoe-to-drum clearance.	______	______
9. Adjusted parking brake cable link at equalizer.	______	______
10. Reinstalled parking brake assemblies following procedure outlined in vehicle manufacturer's service manual.	______	______
11. Completed service correctly.	______	______
12. Observed safety rules and precautions.	______	______
13. Correctly filled out brake system inspection report form.	______	______
14. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 6

Overhaul Kelsey-Hayes-type rear disc brake/parking brake assembly

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Removed caliper following procedure outlined in vehicle manufacturer's service manual.	______	______
4. Removed parking brake parts following outlined procedure.	______	______
5. Cleaned and inspected parts following outlined procedure.	______	______
6. Replaced parts as necessary.	______	______
7. Installed parking brake parts following outlined procedure.	______	______
8. Reinstalled caliper following procedure outlined in vehicle manufacturer's service manual.	______	______
9. Bled brake system.	______	______
10. Completed service correctly.	______	______
11. Observed safety rules and precautions.	______	______
12. Correctly filled out brake system inspection report form.	______	______
13. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST

SERVICE DISC BRAKES

JOB SHEET 7

Overhaul GM Delco-Moraine-type rear disc brake/parking brake assembly

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ______

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained proper equipment and materials.	______	______
2. Properly prepared vehicle.	______	______
3. Prepared and removed caliper following outlined procedure.	______	______
4. Removed parking brake parts following outlined procedure.	______	______
5. Cleaned and inspected parts following outlined procedure.	______	______
6. Replaced parts as necessary and as instructed in outlined procedure.	______	______
7. Installed parking brake parts following outlined procedure.	______	______
8. Bled brake system.	______	______
9. Completed service correctly.	______	______
10. Observed safety rules and precautions.	______	______
11. Correctly filled out brake system inspection report form.	______	______
12. Cleaned work area and returned equipment and materials to proper storage.	______	______

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See "Performance Evaluation Key.") A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

WRITTEN TEST

SERVICE DISC BRAKES

Name ______________________________ Score _______________

OBJECTIVE 1

Choose the definitions that best define the following terms associated with disc brakes. Write the correct numbers in the blanks.

_____a. **Disc brake**

1. Brake design in which brake pads contract against a round, flat braking surface to produce braking action
2. Brake using a ring and curved shoes that expand to contact the inside wall of the ring and stop the vehicle
3. Brake using an external band that contracts to apply friction to a bearing and stop the vehicle

_____b. **Friction**

1. Resistance to heat buildup between two bodies in contact
2. Resistance to relative motion between two bodies in contact
3. Resistance to kinetic energy between two bodies in contact

_____c. **Inboard shoe**

1. Shoe on wheel-cover side of brake disc
2. Shoe on vehicle-frame side of brake disc
3. Shoe on piston side of brake disc

_____d. **Outboard shoe**

1. Shoe on wheel-cover side of brake disc
2. Shoe on vehicle-frame side of brake disc
3. Shoe on piston side of brake disc

_____e. **Pad wear indicator**

1. Thin, metal tab bent so that it contacts rotor and squeals when lining wears to a point where it needs to be replaced
2. Thin piece of metal embedded in pad so that it contacts rotor and squeals when lining wears to a point where it needs to be replaced
3. Computerized sensor that beeps when pad lining wears to the point where it needs to be replaced

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_____f. **Scoring**

1. Light abrasive damage spread over a large area
2. Wear damage from multiple scratches
3. Light corrosive damage spread over a large area

_____g. **Scuffing**

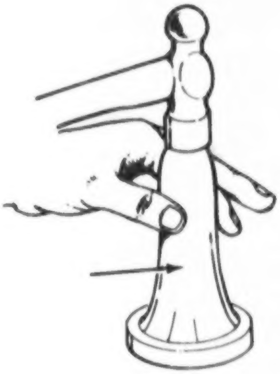
1. Light corrosive damage spread over a large area
2. Wear damage from multiple scratches
3. Light abrasive damage spread over a large area

_____h. **Vane**

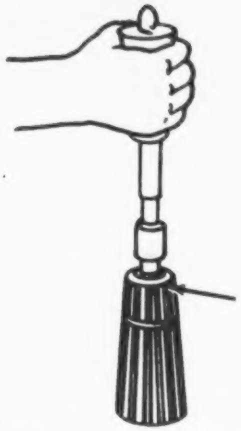
1. Thin bridge between two reservoirs in dual master cylinder
2. Thin bridge between the two disc surfaces of a ventilated disc brake rotor
3. Thin bridge between the two piston surfaces of a ventilated caliper

OBJECTIVE 2

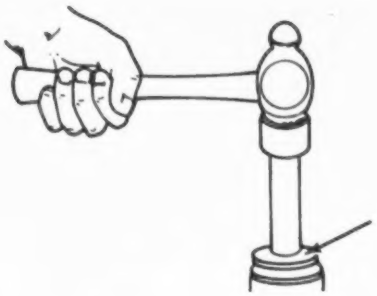
Write the correct names for the disc brake service specialty tools illustrated below and on the following pages.



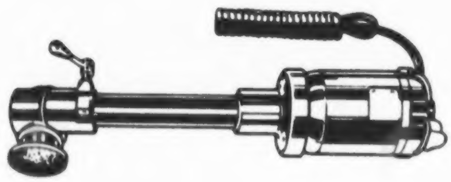
a. ______________________________



b. ______________________________________



c. ______________________________________



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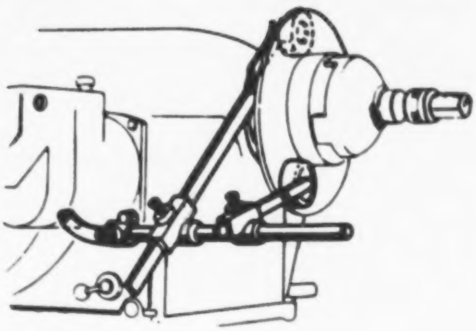
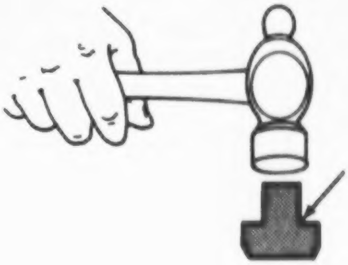
d. ______________________________________

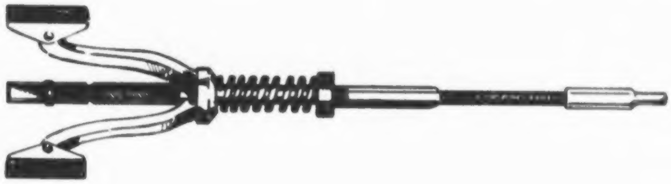


Used with permission of AMMCO Tools, Inc.

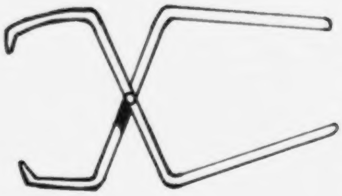
e. ______________________________



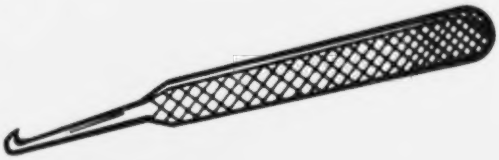
f. ______________________________



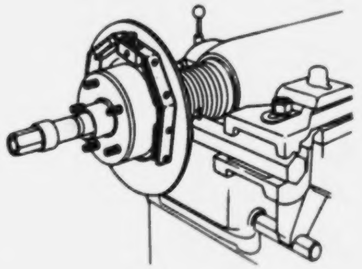
g. ______________________________



h. ____________________

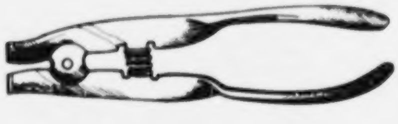


i. ____________________

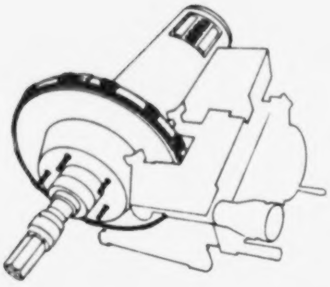


Used with permission of AMMCO Tools, Inc.

j. ____________________



k. ____________________



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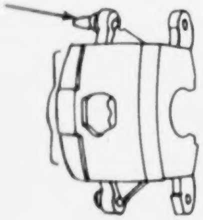
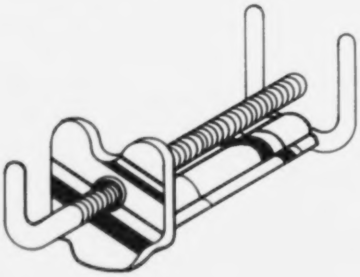
l. ______________________________



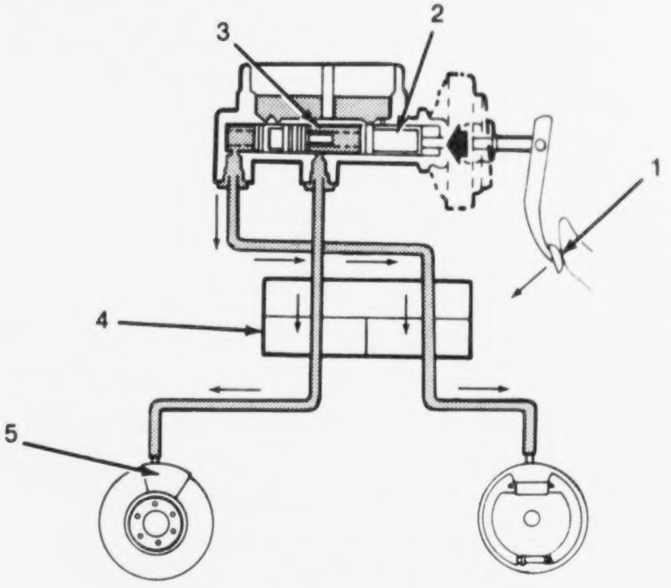
m. ______________________________



n. ______________________________

OBJECTIVE 3

List the steps of disc brake operation in the order numbered on the illustration below.



Used with permission of Ford Motor Company.

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

OBJECTIVE 4

Write the description for each of the types of disc brake calipers listed below.

Fixed caliper — ____

____

____

____

Floating caliper — ____

____

____

____

Sliding caliper — ____

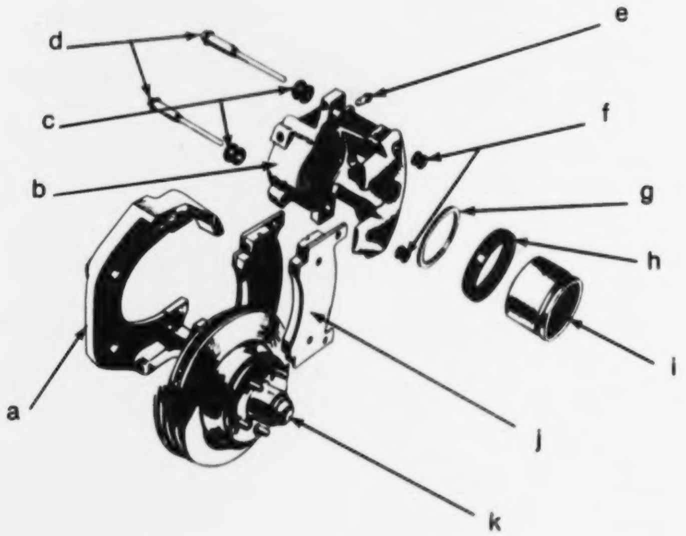
____

____

____

OBJECTIVE 5

Label the parts of the typical floating caliper assembly illustrated below. Write the correct names in the blanks on the following page.



501

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

k. ____________________

OBJECTIVE 6

Recall the advantages of disc brake design by writing the advantages in the spaces below.

a. ____________________

____

b. ____________________

____

c. ____________________

____

d. ____________________

____

e. ____________________

____

OBJECTIVE 11

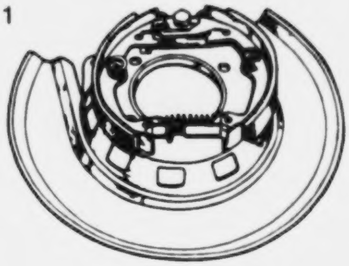
Match the following types of parking brakes used with rear disc brakes to their correct descriptions/names. Write the correct numbers in the blanks.

______a. **GM Delco-Moraine** — Mechanically operated lever connected to a high lead screw—which is passed through a nut in the piston—moves piston along screw to engage brake; integral part of regular brake

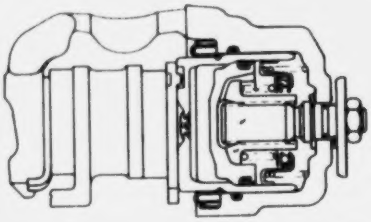
______b. **Kelsey-Hayes (Ford) sliding caliper** — Mechanically operated lever works ball-and-ramp device within parking brake to force pads against rotor; integral part of regular brake

______c. **Rear disc drum (auxiliary drum)** — Cable-operated parking brake with small 6 1/2-inch diameter servo-type brake with star-wheel adjuster; located within rotor hub, independent of regular brake

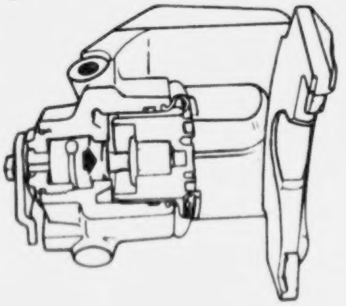
1



2



3



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OBJECTIVE 15

Diagnose the following disc brake problems. Choose the statement below that best diagnoses each of the following disc brake problems. Write the correct numbers in the blanks.

_____a. The owner of a late-model vehicle with front disc brakes, complains of brake chatter when the brakes are applied. You diagnose the problem and determine that the chatter is caused by excessive (beyond the maximum specified) lateral runout of the disc brake rotors. Which of the following would be the proper corrective action?

1. Remachine rotors
2. Install new rotors
3. Hone rotor
4. Recondition rotor with emery cloth

_____b. The owner of a vehicle with front disc brakes relates that it requires excessive pedal effort to stop the vehicle. Which of the following could cause such a condition?

1. Pads worn below minimum thickness
2. Heat-checked rotors
3. Grease, oil, or brake fluid on pads
4. All of the above

_____c. When following up on a customer's complaint of excessive pedal effort, you find that it is necessary to install new brake pads to correct the problem. Which of the following would be the *most likely* cause of the problem?

1. Excessive disc runout
2. Grease and oil on pads
3. Pads worn below minimum thickness
4. Both 2 and 3

_____d. You test drive a vehicle and find that it pulls to one side. Which of the following would be the *most likely* cause of this condition?

1. Seized or frozen pistons
2. Air in system
3. Worn pads
4. Leak past piston cups in master cylinder

_____e. Which of the following would be the *most likely* cause of a scraping sound heard during a test drive?

1. Mud buildup on edges of rotor and caliper housing
2. Sticking pedal linkage
3. Excessive clearance between shoe and caliper
4. Damaged caliper piston seal

NOTE: Turn in your test to your instructor, who will grade the test and determine whether additional training is needed.

WRITTEN TEST ANSWERS

SERVICE DISC BRAKES

OBJECTIVE 1

a. 1
b. 2
c. 2
d. 1
e. 1
f. 2
g. 3
h. 2

OBJECTIVE 2

a. Dust boot installing tool
b. Bearing race remover
c. Seal driver
d. Disc rotor grinder
e. Rotor silencer for use on nonventilated rotors
f. Bearing race driver
g. Caliper cylinder bore hone
h. Dust cap removing tool
i. Piston seal remover
j. Rotor silencer for use when rotor is machined on one side at a time
k. Piston remover
l. Rotor silencing band for use with ventilated rotor
m. Caliper sleeve removing and installing tool
n. Piston installer

OBJECTIVE 3

1. Brake pedal is depressed
2. Pushrod forces primary piston in master cylinder forward
3. Fluid in primary cylinder is pressurized to apply front (disc) brakes
4. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models
5. Piston(s) in caliper forces brake shoe against rotor, thus slowing wheel rotation

OBJECTIVE 4

Fixed caliper — Is rigidly bolted directly to steering knuckle; usually has four pistons, two on each side of rotor

Floating caliper — Is mounted on bolts through rubber bushings that permit it to move; has one large piston, and the braking force is exerted against caliper adapter

Sliding caliper — Is mounted on machined ways that allow it to slide from side to side in caliper adapter, which also receives braking force; has one or two pistons

OBJECTIVE 5

a. Caliper adapter
b. Caliper
c. Bushings
d. Mounting bolts
e. Bleeder screw
f. Bushings
g. Seal
h. Boot
i. Piston
j. Shoe and lining (pad)
k. Disc and hub assembly

OBJECTIVE 6

a. Are resistant to heat fade
b. Are resistant to water fade
c. Provide more straight-line stops
d. Adjust automatically and can be equipped with a pad wear indicator
e. Are easier to service than drum brakes

OBJECTIVE 11

a. 2
b. 3
c. 1

OBJECTIVE 15

a. 2
b. 4
c. 4
d. 1
e. 1